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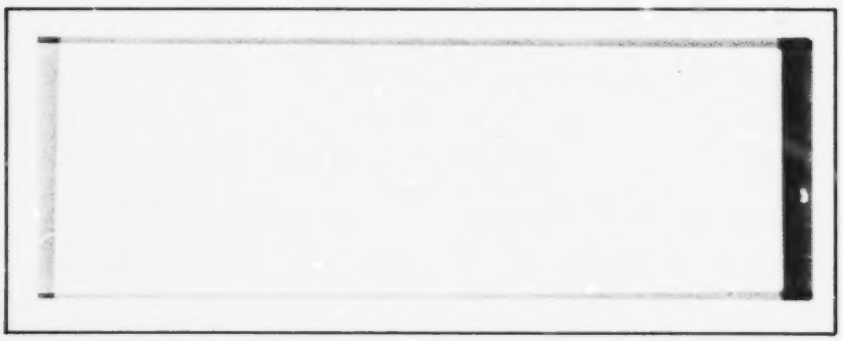

WORKING PAPER

Marketing and Economics Branch

Direction générale de la commercialisation et de l'économie

REVISION OF THE FORECASTING MODEL FOR THE CONSUMER PRICE INDEX FOR FOOD

by

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SUMMARY

In this study a revised forecasting model for the consumer price index for food (CPI-Food) is presented. Estimation results are given and simulation results of the revised model are compared to actual data and to simulation results of the current model.

The inclusion of demand variables, exogenous variables more closely related to retail price movements, improved functional forms and shorter estimation periods have corrected the econometric and structural problems of the current model. The addition of two equations and the simultaneity, particularly in the meat prices section of the model, have improved the model's overall forecasting ability.

Table 3, page 39, summarizes the improvements in forecasting ability as result of equation revision. The highest root mean square percentage error (RMSPE) of the revised model does not exceed 10 while the highest RMSPE of the current model approaches 19. The RMPSE and Theil's inequality coefficient are significantly reduced with most of the revised equations, indicating net improvements in their forecasting behavior.

The extra-sample simulations of both the current and revised models provided another comparison mean (Table 4, page 51). The simulation with the revised model generated a closer fit to actual changes in the index values on five out of six quarters compared to the simulation with the current model. Using the simultaneity embedded in the revised model, the results of dynamic simulations are quite different and approximate real changes in the indexes.

Using the information available as of mid-May, the revised version of the CPI-Food forecasting model generated a forecast 4.4% increase in Canadian food prices in 1983 compared to the current model prediction of a 6.3% increase.

REVISION OF THE FORECASTING MODEL FOR THE CONSUMER PRICE INDEX FOR FOOD

INTRODUCTION

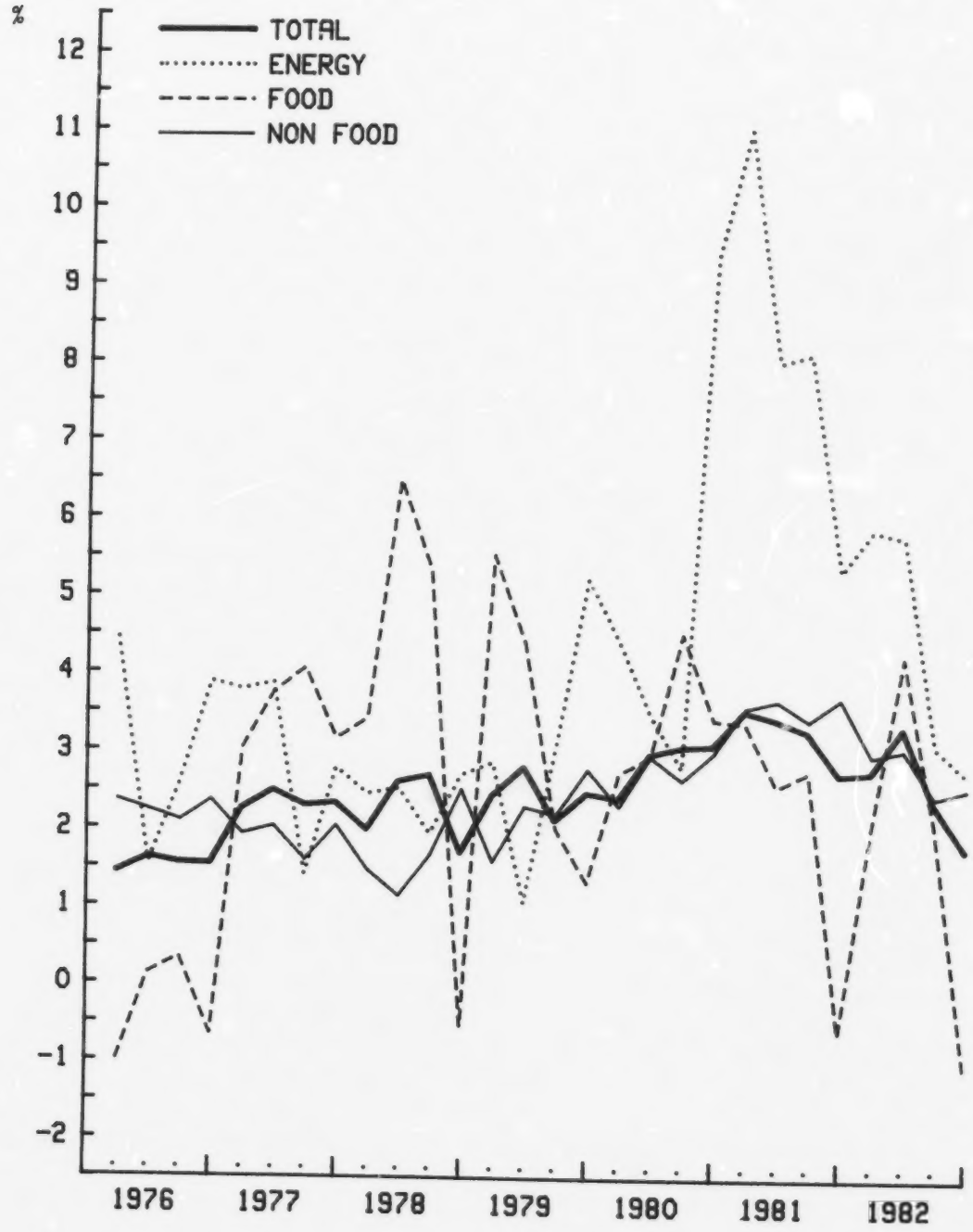
The Consumer Price Index for food (CPI-Food) is one of the most volatile components of the total Consumer Price Index (CPI) (Figure 1). Retail food prices are affected by commodity price movements, marketing costs, exchange rates, demand factors and food chain marketing strategies. Major fluctuations in agricultural supply are caused by adverse weather, diseases, insects and weeds. The output fluctuations can entail in turn dramatic changes in farm commodity prices which directly impact on food prices.

Consequently, accurate forecasts of the CPI-Food, which represents 21.55% of the total CPI, is critical to the prediction of the level of overall inflation in Canada. Moreover, many agencies and government departments are interested in knowing the short and medium-term outlook for food prices. In fact, a forecasting model is a tool that can be used by policy makers, commodity analysts and macro-economists, as well as consumers.

The revision of the food price forecasting model became necessary because of some problems with the quarterly forecasts which have been encountered in the past quarters, both at the aggregate and the item levels. For example, retail price

FIGURE 1

CONSUMER PRICE INDEX YEAR OVER YEAR PERCENT CHANGE, QUARTERLY DATA



SOURCE: STATISTICS CANADA, CATALOGUE 62-010

equations for beef, eggs, and fats and oils produced systematic biases in forecasts and other retail price equations were inconsistently predicting with respect to the likely price index changes.

Objectives

The primary goal of this research project is to improve the quarterly forecasting capabilities of the CPI-Food forecasting model. More specific objectives are:

- to incorporate variables suggested by economic theory and commodity analysts;

- to refine the price behavior equations so as to obtain greater explanatory power for the model;

- to correct econometric problems in the current model.

Forecast and historical explanation are not necessarily attributes of a single model. The challenge is thus to reconcile the forecasting and explanatory abilities of the model.

Outline of the Study

In the first part of this study the current model is analysed. The methodology for the specification of an improved

model, the data and the procedures to assess the quality of the forecasting equations are described in the second part.

In the third part, the specification, estimation results of each equation and validation results are provided.

The last part of this study will show the results of an extra-sample simulation which uses the simultaneity of some equations of the model.(1) This simulation is compared with the one generated by the current model.

PART I. THE CURRENT FORECASTING MODEL FOR THE CONSUMER PRICE INDEX FOR FOOD (CPI-FOOD)[2]

The current Consumer Price Index for Food block of the Food and Agriculture Regional Model (FARM) is a quarterly forecasting model consisting of 24[3] retail price transmission equations and 8 aggregation equations from which the Consumer Price Index for Food is derived.

Items in the CPI predicted by components of the FARM model are the retail price indexes for cereal and bakery products, fats and oils (excluding butter), beef, pork, chicken, turkey, eggs, fluid milk, butter, cheddar cheese, processed cheese, powdered skim milk, evaporated milk and ice cream. Retail price indexes for sugar and sugar preparation, processed fruits, processed vegetables, apples, oranges, bananas, lettuce, tomatoes and potatoes are predicted by 9 equations independently of the commodity components of the FARM model.

The aggregate equations generate forecasts for the meat, poultry and fish index, the dairy product (including butter) index, the fresh fruit and fresh vegetables indexes, the indexes for food purchased from stores and food purchased from restaurants, and the aggregate CPI-Food.

The specification of the model is based on a cost-push theory of retail price determination: changes in farm-level prices or import prices and in marketing costs (e.g. wages, energy

costs, interest rates) determine price changes at the retail level. The cost-push theory of inflation underlying the specification of the model is consistent with a view of food price inflation as predominantly a supply-shift phenomenon.(4)

Two types of equations are employed for the price transmission equations: the conventional linear form and the linear form with both dependent endogenous and explanatory exogenous variables expressed as a logarithm of the relative quarterly change. The aggregation equations use both the conventional linear form and the identity.

The 14 price indexes endogenous to the commodity components of the model account for 39% of the weight of the CPI-Food and the 9 indexes exogenous to the commodity components account for another 13% of the weight of the CPI-Food.(5) That is, 52% of the CPI-Food is forecast and used to generate the CPI-Food forecast under the assumption that prices of omitted items move in the same manner as included items.

The retail price transmission equations generate forecast values for the initial block of 24 price indexes. These initial forecast values are then used to solve the retail price aggregation equations. The equations are thus partly independent and partly recursive.

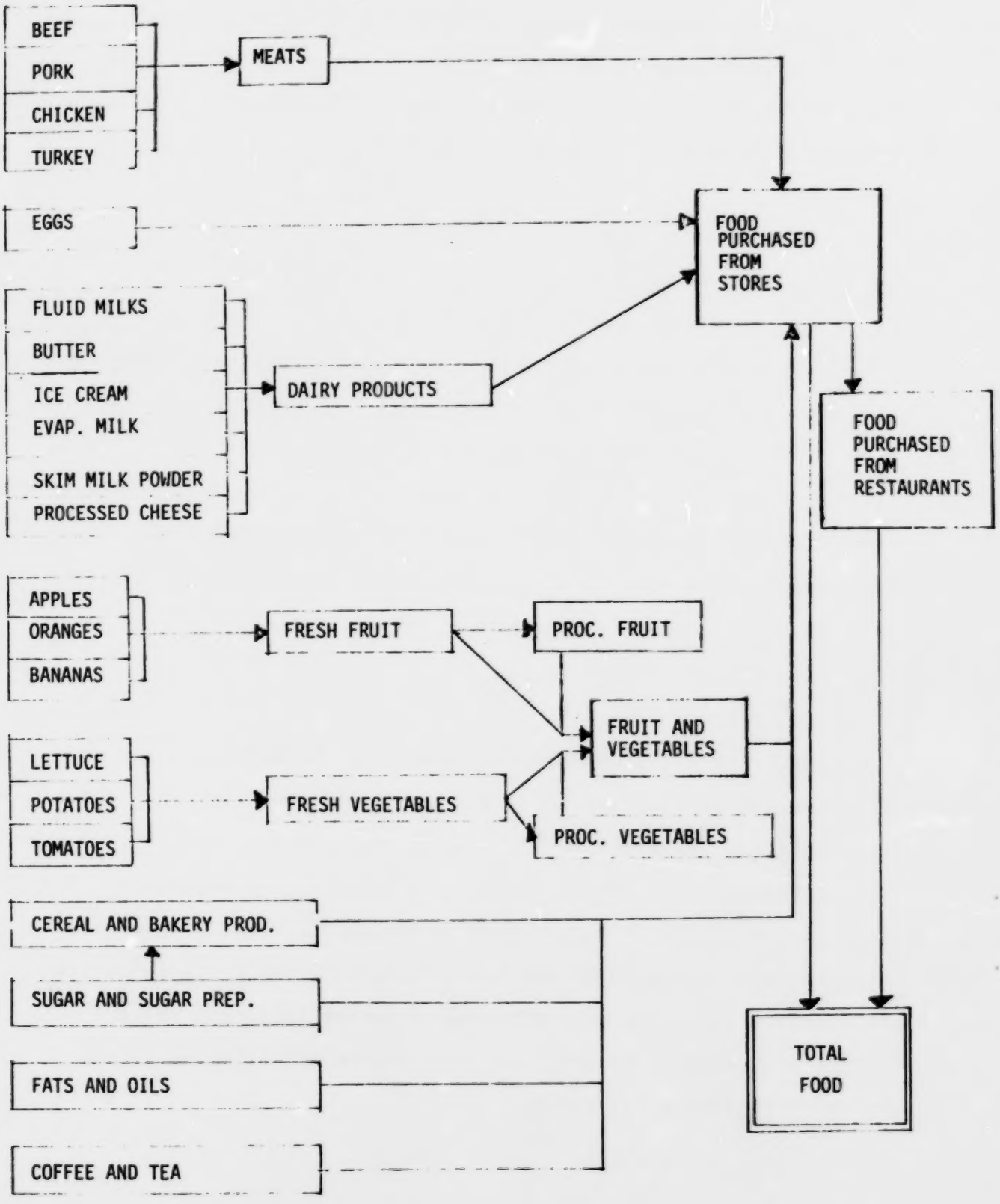
The estimated model is currently based on quarterly data from the first quarter of 1969 to the closest possible quarter available. The model is usually solved in its reduced form for future values of the endogenous variables up to 8 quarters in advance.

Review of the Current Model

Extra-sample simulations have given some information on the forecasting ability of each equation. In doing so, we have used the estimated coefficients over the period 1971 Q1-1980 Q4 to solve the model for the six following quarters. The results show that at least 15 equations were not tracking the prices they were intended to forecast. That is, either the inflexion points were not reproduced in the simulation or the simulation-predicted price trend did not correspond to the actual trend.

These difficulties in tracking price movements and locating inflexion points of the price curve over time may be due to the lack of appropriate variables. For example, chicken, turkey and eggs prices are all modeled on the same structure. The specific regulated producer price, seasonal dummies, a wage rate and the lagged dependent variable are used in the three equations. In reality, the price determination processes beyond producer prices are quite different, and this should be reflected in the set of explanatory variables.

FIGURE 2 - FLOW CHART OF THE CURRENT CPI-FOOD MODEL



Multicollinearity, autocorrelation, the lack of explanatory demand variables, the lack of significance in many parameters and the inability to track some price indexes are the most critical problems encountered with the current model.

An estimation by the "ordinary least squares" method of all the equations over the last decade revealed that at least 11 equations had multicollinearity problems and 9 equations had non-efficient estimators since the residual errors were correlated. For example, the retail price equations for eggs, lettuce, fats and oils, sugar and confections, and coffee and tea belonged to the first group while the price equations for chicken and processed vegetables belonged to the second. In some equations important variables were not significant and, as indicated earlier, demand factors were not used in these specifications.

The econometric problems identified by the examination of the estimated results may be a consequence of the way the price determination or transmission mechanisms are translated into equations. This situation may be due mainly to the 9 equations with autocorrelated residuals. However, the multicollinearity problem usually entails instability in the coefficients estimated and, in general, drastically reduces the reliability of the forecasting equations.

The main structural problem noticed is the lack of demand variables in the price transmission equations. Demand conditions appear in other parts of the FARM model, but no account is taken of the influence of demand on retail prices beyond the wholesale or sometimes beyond the farm gate. As the supply of food is not infinitely elastic, consumer demand can theoretically have an impact on the price for food.(6)

To tackle these econometric and structural problems, investigations have been carried out to find the best functional form and to establish a set of explanatory variables suited to the particular behavior of each commodity price. Economic theory, input-output studies, advice from commodity specialists and the history of price behavior have all been taken into account in the construction of the model.

PART II - THE REVISED MODEL

The equations specified for the CPI-Food forecasting model represent the relationships between retail food price changes and producers' prices, factor prices, demand characteristics and expectations.

Variables Included

The revision of the model includes some modifications to the set of explanatory variables. New variables are used in both the endogenous and exogenous variable sets and some of the current exogenous variables in the beef and pork price equations have been deleted.

Two additional price groups, namely the CPI for other foods purchased from stores and the CPI for prepared and partially prepared main dishes, are now directly forecast. This increase the proportion of the total CPI with some direct commodity forecast from 52% to 61%. This will most likely improve the accuracy of the aggregate CPI-Food forecast because when sub-indexes are not forecast individually, it is assumed in the aggregation equation that these non-forecast sub-indexes effectively follow the behavior of all other forecast CPI.

Exogenous variables added to the CPI-Food block either come from other parts of the FARM model or from extraneous

sources. They include 7 new dummy variables, which reflect particular events in the history of commodity markets, as well as 8 explanatory variables.

The FARM variables added to the CPI-Food block are chicken disappearance, per capita disposable income, the price of soybean meals in eastern Canada and the wage index in Canadian slaughtering and packing plants.

The new variables added are the average farm price of lettuce in Canada,(8) the unit import price of tea,(9) the domestic supply of turkey(10), and the wholesale price of potatoes in Canada(11). A priori it may be expected that the domestic price of lettuce has an impact on the retail price in the summer months. The same applies to the unit import price of tea which is expected to impact on the coffee and tea retail price index. It is also known that the domestic supply of turkey, defined as production plus previous period stocks, has a predominant role in the determination of the retail price of turkey during festive times of the year. Finally, domestic wholesale prices for potatoes were included in the retail price determination process because domestic production accounts for most of Canadian consumption.

Following the hypothesis that better price indicators could be found for some commodities, some variables appearing in the current CPI-Food model have been deleted in the revision after

testing their statistical significance. For example, the closing stocks of beef in eastern and western Canada were not significant variables, when the wholesale price of steer carcasses was used. The same was true of the retail pork price equation: the closing stocks of pork in eastern and western Canada did not help forecast the retail price of pork since the Ontario price of hogs (Index 100) is a reliable indicator for Canadian pork prices. The wholesale price of (A1) steer carcasses in Edmonton (western Canada) has been shown to be superfluous when the wholesale price of A1 steer carcasses in Toronto is used as the input price indicator.

Consistency with Economic Theory

Retail prices are determined by wholesale prices, and wholesale prices by farm prices. However, the margins between each price level are not governed by any exact rule. Without forecast margins, the retail price determination process should make use of the available commodity price indicator that is the closest to the retail price. The adverse effects of unexplained margin modifications are thus avoided. Most of the commodity retail price equations presented in the following section of this report satisfy this requirement: the wholesale price is used whenever possible as the commodity price indicator.

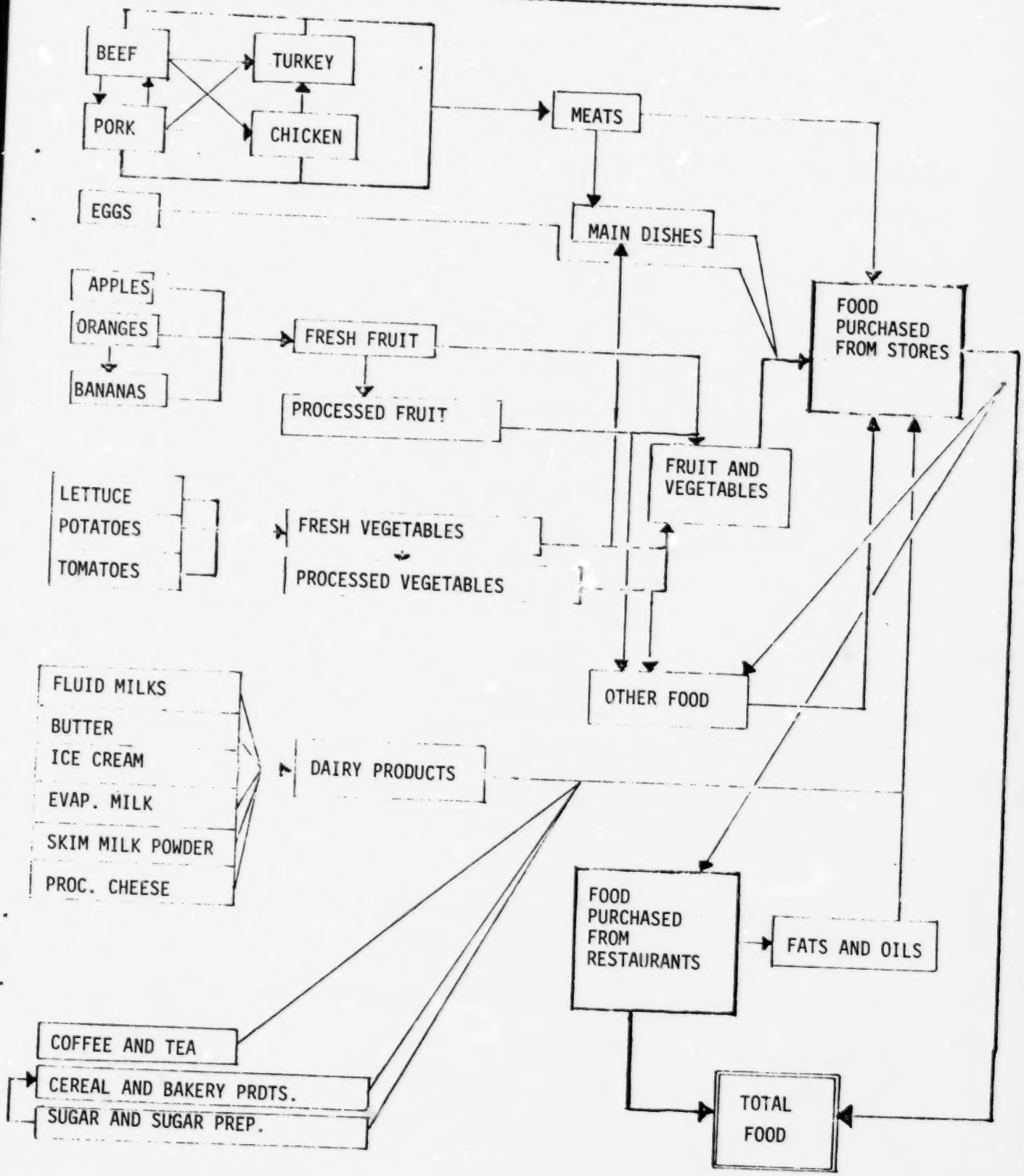
Retail prices are determined by wholesale prices, but other factors also influence retail prices. These factors include

demand characteristics, retailing practices, marketing costs, expectations and availability.

The specification of the equations has been directed by these broad characteristics of food price determination, as well as by statistical criteria. The representation of food price determination resulting from such specification guidelines assumes that price determination is unidirectional. That is, it is assumed that wholesale or farm price movements are transmitted to retail prices. In fact, simultaneity in those price movements is not unlikely.

Considering this causality pattern one can a priori define the expected signs of most coefficients. Input price coefficients should be positive as input prices are passed to the retail market. Demand factor coefficients should be positive or negative according to the nature of the variable. The income coefficients are expected to be positive as long as we are dealing with non-inferior goods. The coefficients of substitutes and complements should be positive and negative respectively. Finally, the signs of expectation variables will depend on each particular market and on the consumer's ability to substitute one good for another.(12) A high degree of market power, for example, usually implies that the coefficients of lagged price variables are positive, while a high substitutability for consumers means that the market power effect on prices may be nulified by consumer behavior. Consumers expect that, if the market power is strong,

FIGURE 3 - FLOW CHART OF THE REVISED CPI-FOOD MODEL



the previous pattern of price change will likely repeat itself. On the other hand, if consumers can easily substitute one good for another, the demand for the item under high market power may drop and the previous price movement may not affect the current price change.

Functional Forms

In relation to statistical problems in the current model, the choice of a functional form was decided by one criterion: the functional form used should allow the reproduction of endogenous price index movements. With this criterion in mind, the author chose to estimate most of the equations using quarterly rates of price changes rather than price levels, for both dependent and explanatory variables. This procedure alleviates the multicollinearity problems because price levels tend to be more collinear than the rate of change of these prices. Consequently, singularity of the matrix of the value of dependent variables can be avoided and coefficients are more stable.

Another advantage of the rate of change functional form is the ease of coefficient interpretation: all coefficients are elasticities. Morover, forecasts using a rate of change functional form are more accurate in terms of future price changes than in terms of future price levels, since the specification explains price movements rather than price levels. After all,

price index levels are not as of much interest as price index changes.

The results obtained from such a functional form seem much more satisfactory than estimates obtained with other forms. However, this functional form does make the modeling task more complex, since a greater number of variables in the set of explanatory variables to be tested can be considered.

This relative change functional form may, however, produce correlated residuals, but Durbin-Watson statistics did not detect any serious problem of first-order autocorrelation.

Econometric Procedures

A number of criteria were used to compare forecasts and to assess their absolute and relative accuracy. All forecasts and simulations were ex-post.

The first criteria is visual: plotting the actual value of the explained variable against its value generated by the corresponding equation. This provided the necessary evidence to judge whether the equation was adequately tracking the endogenous variable. In all cases these simulations were performed beyond the estimation sample period. Intra-sample validation was also carried out.

The other criteria were statistical. The usual mean percentage error (MPE) and root mean square percentage error (RMSPE) were used to indicate the bias in forecast and the precision of the forecast respectively. Theil's decomposition of the RMSPE was calculated to indicate the proportion of bias. A measure of dispersion was also considered: the mean absolute percentage error (MAPE). And finally, a ranking of forecasts was possible using Theil U'.(13) If U' is large, the average predicted change deviates substantially from the average actual change. U' tends to reach zero in the case of perfect forecast.

In the case of an equation specified with percent change in variables, the MPE and RMSPE were considered both for the relative change forecast and for the forecast values of the price index levels. All the measures of forecast quality listed in this report (Table 3, page 39), however, refer to errors with respect to the value of the price index level. In general, the value forecast for the endogenous price index is less precise than the forecast for percent change in the endogenous variable when the equation is specified with variables transformed into relative changes.

Data*(16)

All quarterly endogenous variables are items or components of the CPI in Canada, as published by Statistics Canada in "Consumer Prices and Price Indexes" (Catalogue No. 62-010). The CPI (and

its components) is a composite price index based on a constant-basket concept; its value at any point represents the percentage change over time since a base year (currently 1981) in the cost of a constant collection of goods and services. Continuous time series are available from 1949 for most of the basket items, although their weights in the all-item CPI have been revised periodically, most recently in 1982. The weights now reflect 1978 purchases by families and unattached individuals living in private households in urban centers with populations of 30000 or more.(14) In order to simplify the CPI-Food block, the 1978 expenditure weights are used historically as well as currently. It is presumed that the degree of inaccuracy induced by this procedure will be insignificant relative to normal stochastic error. This is because changes in weights are marginal through the time path considered in the estimation of the model.

The quaterly exogenous variables are derived from different sources. Macroeconomic variables such as the exchange rate, the interest rate the price of blended oil (a proxy for energy costs) all come from the Conference Board of Canada's series (The Canadian Economy, 1961-1980 Data and Quarterly Canadian Forecast (various issues)).

All other exogenous variables are taken or derived from the FARM data base except the following: implicit unit import prices for bananas, lettuce, oranges, potatoes, tomatoes and tea. These are obtained from data published by the External Trade Division of Statistics Canada.

The average farm price of lettuce and wholesale prices for potatoes are calculated from data published by Agriculture Canada in the Fruit, Vegetables and Honey, Crops and Market Report.

The international price of coffee under the 1968 International Coffee Agreement and the price of sugar under the International Sugar Agreement are obtained from daily prices published in UNCTAD, Monthly commodity price bulletin.

PART III - RESULTS

Analysis of the Estimation Results

The ordinary least squares estimation results are given in Table 1 (pages 27-28). Most of the estimated coefficients have the expected sign and the appropriate magnitude. Coefficients and related statistics are given in Table 1.

The results show that farm or wholesale prices and prices substitutes and complements are the major explanatory factors for the retail prices of most commodities. Substitution factors appear to have the greatest effect for the various meats considered. Complementarity in consumption is mostly significant for retail fruit and vegetable price equations.

The outstanding characteristic of the estimated equations is the low order of lags. Farm and wholesale prices, demand factors and distribution and retailing costs all have an almost immediate impact on food prices. For example, it is estimated that a 10% increase in the price of hogs prompts, ceteris paribus, a 3.1% increase in the retail pork price index in the same quarter. This increase in the price of hogs will generate a further 2.3% increase in the CPI-Pork in the following quarter and will not have any significant impact thereafter.

One of the main features of the revised model is the presence of demand factors in the modeled pricing process. These

demand factors have also induced some simultaneity in the high protein food group as well as in fats and oils and the food purchased from restaurants component. In other words, current endogenous prices are part of the right hand side of the equations for meat, food purchased from stores and aggregation price equations.

As previously stated, one constraint in this research is the fact that all equations must be estimated using ordinary least squares. This constraint has curtailed the possibility to take into account the simultaneity in the estimation process. Thus it was assumed that these coefficients approximate the coefficients that would have been obtained using a three-stage least square estimator, although this method would have produced more efficient coefficients. However, the approximation remains to be verified by experimentation.

Because of the different nature of the food commodities and their markets, the explanatory variables have different roles depending on which equation they appear in. Farm and wholesale prices generally dominate all other variables since raw material inputs represent the most important cost in food production. The statistical significance of their coefficient is higher than for any other variables.

The exchange rate plays a significant role in food price determination. Beside the impact of the exchange rate

embeded in the import prices, the exchange rate itself has an impact on food prices due to potential and actual trade in some markets. Apart from fruits and vegetables, the major commodities whose prices are directly dependent on the value of the Canadian dollar are beef, pork, fats and oils, sugar and sugar preparations, coffee and tea.

Sharp increases in energy costs over the last decade have influenced the price behavior of all food commodities. However, a change in energy prices does not have the same impact on the all retail prices. For most commodities, such as eggs, chicken, processed fruit and vegetables, sugar and confections and coffee and tea, an increase in the proxy for energy costs (the price of blended oil) is transmitted quickly to the retail price. For some commodities, like beef and fats and oils, increased energy costs provoke a liquidation of stocks which increases the retail supply enough to induce downward presures on retail prices.

The same relationship exists between beef prices and changes to interest rates and wages. Increased processing storage and distribution costs tend to increase the supply on the retail counter. In the short run, increased costs for storage and handling are not passed to the consumer. Packers and retailers tend instead to move more beef in order to reduce inventory costs. After one quarter these cost increments are passed to the consumer.

This short-run retail price change due to cost changes is characteristic of the market beyond the wholesale level. Because the wholesale price movement is not fully transmitted in one quarter to the retail price, there is room for adjustment in stocks through a lag in the wholesale price movement transmission.

The statistical assessment of this pricing behavior is that all three coefficients for wages, energy and interest rates are jointly significant when an F test is used (page 29).

Increases in interest rates exert upward pressure on some commodity retail prices even beyond the producer level: retail prices for pork, fats and oils and food purchased from restaurants, for instance (Table 1, pages 27-28).

Demand factors have been proxied by income and prices of substitutes and complements. Changes in per capita disposable income are transmitted rapidly to retail prices through consumer demand. The estimated income price elasticity for beef is 0.26, 0.14 for chicken, 0.09 for coffee and tea and 0.02 for food purchased from restaurants. A lag structure can be identified; changes in per capita income precede their impact on retail prices by one quarter for coffee and tea and food purchased from restaurants. It is estimated that all changes in substitute prices have a positive impact on food retail prices, while complement prices have a negative impact on retail prices and thus on demand. For example, changes in pork prices have an estimated

positive impact on the retail beef price while the changes in the retail price of tomatoes have a negative impact on the price of lettuce.

Substitution in the meat food group has played a major role in the modeling of the price determination processes. Substitute and complement price movements have also had a significant role in modeling some fruit and vegetables retail price behavior.

In the meat group, substitution also has a lag structure. An increase in beef and pork prices has a positive effect on the demand for chicken after one quarter. The estimated elasticities for these lagged substitution factors on chicken prices are 0.08 and 0.14 for beef and pork prices respectively. An increase in beef prices in the third quarter prompts an increase in turkey prices for the fourth quarter according to an estimated elasticity of 0.57.

Because changes in input prices and marketing costs are only partially transmitted to successive processing stages in the same period,(15) changes in some quarterly input prices lag behind some retail price changes. Beef, pork, turkey, eggs and coffee are the main commodities where such a process occurs.

Price leveling is a retailing practice which adds to this inertia in the price transmission process. Since the

consumer and the retailer prefer to see some stability in prices, retailers do not immediately transmit their full cost changes for material. The retailer's aim is to reduce price fluctuations, and so his expectations of future material and marketing costs are also used in setting retail prices.

Expectations for food commodity prices are generally approximated by a first-order autoregressive process. However, price expectations in the meat group are dependent upon retail beef price expectations and, more generally, on retail prices for substitutes. In other words, the only first-order autoregressive process exists in the retail beef price equation, while other meat price equations use the retail beef price and/or other retail substitutes prices as explanatory variables.

The following tables (Tables 1 and 2, pages 24-34) provide the Ordinary Least Square (OLS) estimation results for each equation of the model, the main statistics and a definition of the mnemonic variable names.

TABLE 1. The Revised Version of the CPI-Food Forecasting Model*

$$\dot{RPBF3} = \underset{(2.45)}{0.02} - \underset{(-1.45)}{0.03}\,JS2 - \underset{(-0.73)}{0.02}\,JS3 + \underset{(0.72)}{0.18}\,\dot{ER34} - \underset{(-0.96)}{0.04}\,\dot{PBOIL3} - \underset{(0.04)}{0.01}\,\dot{RFC3} + \underset{(12.53)}{0.71}\,\dot{WPSS2} + \underset{(0.55)}{0.04}\,\dot{RPPK3} + \underset{(0.49)}{0.06}\,\dot{RPBF3}(-1) + \underset{(1.95)}{0.22}\,\dot{PCDY3} - \underset{(-2.96)}{0.59}\,\dot{WAPK3} + \underset{(2.03)}{0.21}\,\dot{WPSS2}(-1)$$

$$\dot{RPPK3} = \underset{(-0.97)}{-0.01} - \underset{(-0.03)}{0.003}\,JS1 - \underset{(-1.57)}{0.32}\,JS2 + \underset{(3.36)}{0.03}\,JS3 + \underset{(11.38)}{0.32}\,\dot{PHG2} + \underset{(8.11)}{0.21}\,\dot{PHG2}(-1) + \underset{(1.69)}{0.25}\,\dot{WAPK3} + \underset{(2.31)}{0.11}\,\dot{RPBF3} + \underset{(1.70)}{0.35}\,\dot{ER34} + \underset{(1.24)}{0.02}\,D82$$

$$\dot{RPEG3} = \underset{(-1.39)}{-0.02} + \underset{(1.59)}{0.01}\,JS1 + \underset{(2.42)}{0.01}\,JS3 + \underset{(1.73)}{0.01}\,JS4 + \underset{(18.21)}{0.52}\,\dot{XPEG3} + \underset{(0.83)}{0.02}\,\dot{RPBF3} + \underset{(2.75)}{0.04}\,\dot{PBOIL3} + \underset{(6.33)}{0.17}\,\dot{XPEG3}(-1) + \underset{(0.95)}{0.0001}\,TIME$$

$$\dot{RPCK3} = \underset{(2.12)}{0.01} - \underset{(-3.58)}{0.05}\,JS1 + \underset{(3.28)}{0.30}\,\dot{XPCK3} + \underset{(2.77)}{0.25}\,\dot{RPPK3} + \underset{(1.07)}{0.08}\,\dot{RPBF3}(-1) + \underset{(0.71)}{0.07}\,\dot{PCDY3} + \underset{(1.28)}{0.12}\,\dot{RPPK3}(-1) + \underset{(2.36)}{0.08}\,\dot{PBOIL3} + \underset{(3.10)}{0.23}\,\dot{RPBF3} - \underset{(-3.33)}{0.38}\,\dot{DCK3}(-1) - \underset{(-0.08)}{0.02}\,\dot{ER34} - \underset{(-0.49)}{0.05}\,\dot{DCK3} + \underset{(0.64)}{0.02}\,D8201 - \underset{(-2.21)}{0.06}\,D82Q2$$

$$\dot{RPTK3} = \underset{(0.90)}{0.01} - \underset{(-0.26)}{0.01}\,JS1 + JS123\,(\underset{(0.86)}{0.13}\,\dot{RPCK3} + \underset{(1.45)}{0.15}\,\dot{RPPK3} + \underset{(1.49)}{0.16}\,\dot{XPTK3} + \underset{(2.15)}{0.25}\,\dot{XPTK3}(-1) - \underset{(-0.59)}{0.02}\,\dot{TDSTK3}) + JS4\,(\underset{(1.46)}{0.77}\,\dot{XPTK3} + \underset{(2.05)}{0.26}\,\dot{XPTK3}(-1) + \underset{(3.12)}{0.55}\,\dot{RPBF3}(-1) - \underset{(-2.15)}{0.07}\,\dot{TDSTK3}(-1)$$

$$LOG\,(\dot{RPMT3}) = \underset{(0.73)}{0.0009} + \underset{(0.97)}{0.002}\,JS1 + \underset{(3.99)}{0.002}\,JS2 + \underset{(0.31)}{0.0005}\,JS3 + \underset{(62.42)}{1.16}\,(\underset{(1.92)}{1.92}\,LOG\,(\dot{RPBF3}) + \underset{(1.15)}{1.15}\,LOG\,(\dot{RPPK3}) + \underset{(0.58)}{0.58}\,LOG\,(\dot{RPCK3}) + \underset{(0.16)}{0.16}\,LOG\,(\dot{RPTK3}))/\underset{(5.25)}{15.19} + \underset{(5.25)}{0.08}\,LOG\,(\dot{RPMT3}(-1))$$

$$\dot{RPFM3} = \underset{(-2.21)}{-3.17} + \underset{(6.21)}{2.09}\,\dot{XPFM3} - \underset{(-2.53)}{4.37}\,\dot{XCSUM3} - \underset{(-0.85)}{0.02}\,(\dot{DMS3} + \dot{DLM3} - \dot{DMS3}(-1) - \dot{DLM3}(-1)) + \underset{(14.33)}{0.72}\,\dot{RPFM3}(-1)$$

$$\dot{RPIC3} = \underset{(2.34)}{14.48} + \underset{(0.51)}{1.12}\,JS1 + \underset{(0.62)}{1.42}\,JS2 + \underset{(0.36)}{0.79}\,JS3 + \underset{(3.09)}{0.33}\,\dot{WPIC3} + \underset{(0.05)}{0.002}\,\dot{RPEN3} + \underset{(3.20)}{0.53}\,\dot{RPIC3}(-1)$$

$$\dot{RPCB3} = \underset{(-1.15)}{-0.70} + \underset{(15.65)}{50.43}\,(\dot{XWPCB3} - \dot{XWPCB3}(-1)) + \underset{(288.83)}{1.01}\,\dot{RPCB3}(-1)$$

$$\dot{RPMG3} = \underset{(-1.00)}{-2.44} + \underset{(9.74)}{0.06}\,PSL4(-1) + \underset{(5.88)}{0.10}\,\dot{RPEN3} + \underset{(22.96)}{0.76}\,\dot{RPMG3}(-1)$$

$$\dot{RPPC3} = \underset{(-0.07)}{-0.12} + \underset{(5.13)}{20.28}\,\dot{WPCH3} + \underset{(2.94)}{0.08}\,\dot{RPEN3} + \underset{(9.37)}{0.66}\,\dot{RPPC3}(-1)$$

$$\dot{RPPM3} = \underset{(3.40)}{6.98} + \underset{(9.95)}{57.75}\,(\dot{XWPPM3} - \dot{XCSUP3}/100) + \underset{(2.45)}{0.08}\,\dot{RPEN3} + \underset{(11.14)}{0.57}\,\dot{RPPM3}(-1)$$

$$\dot{RPEM3} = \underset{(-1.56)}{-3.20} + \underset{(24.40)}{1.04}\,\dot{WPEM3} + \underset{(0.76)}{0.03}\,\dot{RPEN3}$$

$$LOG\,(\dot{RPDP3}) = \underset{(121.07)}{1.19}\,(\underset{(1.15)}{1.15}\,LOG\,(\dot{RPFM3}) + \underset{(0.22)}{0.22}\,LOG\,(\dot{RPCB3}) + \underset{(0.35)}{0.35}\,LOG\,(\dot{RPPC3}) + \underset{(0.03)}{0.03}\,LOG\,(\dot{RPPM3}) + \underset{(0.05)}{0.05}\,LOG\,(\dot{RPEM3}) + \underset{(0.14)}{0.14}\,LOG\,(\dot{RPIC3}))/2.31$$

$$\dot{RPCL3} = \underset{(-2.02)}{-17.24} + \underset{(2.72)}{0.11}\,\dot{XPWH3} + \underset{(1.81)}{0.08}\,(\dot{XPWH3} - \dot{XPWH3}(-1)) + \underset{(2.46)}{0.45}\,(\underset{(2.26)}{0.2}\,\dot{WA3} + \dot{PBOIL3}) + \underset{(0.57)}{22.13}\,\dot{ER34} + \underset{(3.64)}{0.13}\,\dot{RFC3} + \underset{(9.01)}{0.04}\,\dot{RPSG3} + \underset{}{0.71}\,\dot{RPCL3}(-1)$$

$$
\begin{aligned}
RPAP3 &= -243.85 - 16.92\,JS1 - 15.99\,JS2 - 54.40\,JS3 + 1.62\,IMPAP3 - 0.91\,JS1\,(IMPAP3) - 0.0001\,JS2\,(IMPAP3) + 4.16\,JS3\,(IMPAP3) + 2.64\,(IMPAP3 - IMPAP3(-1)) + 2.05\,(0.2\,WA3 + PBOIL3) + 288.12\,ER34 \\
&\quad (-1.96)\ (-0.40)\ (-0.38)\ (-1.24)\ (0.46)\ (-0.29)\ (-0.0002)\ (1.48)\ (1.17)\ (3.44)\ (1.97)
\end{aligned}
$$

$$
\begin{aligned}
RPBN3 &= -20.33 + 7.10\,JS1\,(IMPBN3) + 7.93\,JS2\,(IMPBN3) + 7.37\,JS3\,(IMPBN3) + 6.00\,JS4\,(IMPBN3) + 0.68\,RPBN3(-1) + 0.07\,JS4\,(RPOR3) + 13.74\,JS3\,(IMPBN3 - IMPBN3(-1)) \\
&\quad (-3.24)\ (4.34)\ (5.02)\ (4.12)\ (2.80)\ (8.25)\ (0.81)\ (3.63)
\end{aligned}
$$

$$
\begin{aligned}
RPOR3 &= -99.54 + 21.87\,JS1 + 26.73\,JS2 + 20.99\,JS3 + 11.69\,IMPOR3 - 1.13\,JS1\,(IMPOR3) - 0.04\,JS2\,(IMPOR3) - 0.50\,JS3\,(IMPOR3) - 3.45\,(IMPOR3 - IMPOR3(-1)) + 0.59\,WA3 - 3.77\,PBOIL3 \\
&\quad (-4.85)\ (1.08)\ (1.40)\ (1.15)\ (10.52)\ (-0.84)\ (-0.02)\ (0.45)\ (-2.76)\ (-5.92)\ (-4.12)
\end{aligned}
$$

$$
\begin{aligned}
RPFR3 &= -38.94 + 0.01\,JS1 + 9.54\,JS2 + 9.01\,JS3 + 0.37\,RPAP3 + 0.25\,RPBN3 + 0.42\,RPOR3 + 0.62\,TIME \\
&\quad (-3.41)\ (0.01)\ (4.01)\ (3.28)\ (16.26)\ (8.33)\ (15.60)\ (2.66)
\end{aligned}
$$

$$
\begin{aligned}
RPPFR3 &= -52.28 + 0.09\,(RPFR3 + RPFR3(-1) + RPFR3(-2) + RPFR3(-3)) / 4 + 0.69\,(0.2\,WA3 + PBOIL3) + 61.06\,ER34 + 0.61\,RFC3 + 0.01\,RPSG3 + 0.58\,RPPFR3(-1) \\
&\quad (-3.63)\ (2.61)\ (4.84)\ (3.74)\ (3.20)\ (0.79)\ (7.58)
\end{aligned}
$$

$$
\begin{aligned}
PPLET3 &= 16.81 + 13.33\,IMPLET3 + 86.93\,D7782 + 293.28\,JS3\,(AFPLET3) - 0.11\,JS3\,(RPTT3) + 34.63\,D81Q3 + 0.99\,JS1\,(IMPLET3) + 0.71\,JS2\,(IMPLET3) - 9.57\,JS3\,(IMPLET3) \\
&\quad (2.47)\ (15.25)\ (12.06)\ (2.91)\ (-0.88)\ (1.71)\ (1.97)\ (1.40)\ (-2.56)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPPW3} &= -0.18 + 0.22\,JS1 + 0.28\,JS2 + 0.48\,JS3 - 0.89\,JS2\,(\dot{IMPPW3}) + 1.36\,JS3\,(\dot{IMPPW3}) + 0.50\,\dot{WPPW3} \\
&\quad (-5.75)\ (4.33)\ (5.21)\ (10.33)\ (-2.34)\ (4.54)\ (5.38)
\end{aligned}
$$

$$
\begin{aligned}
RPTT3 &= -233.49 + 3.83\,JS1 + 9.00\,JS2 - 5.88\,JS3 + 5.83\,IMPTT3 - 0.53\,(\dot{IMPTT3} - IMPTT3(-1)) + 0.08\,(0.2\,WA3 + PBOIL3) + 222.48\,ER34 - 0.35\,RFC3 + 0.33\,RPTT3(-1) \\
&\quad (-2.98)\ (0.64)\ (1.48)\ (-0.94)\ (5.34)\ (-0.54)\ (0.24)\ (2.63)\ (-0.33)\ (1.98)
\end{aligned}
$$

$$
\begin{aligned}
RPVG3 &= -13.27 + 11.83\,JS1 + 16.97\,JS2 + 16.41\,JS3 + 0.25\,RPLET3 + 0.26\,RPPW3 + 0.39\,RPTT3 - 0.09\,(0.2\,WA3 + PBOIL3) + 20.34\,ER34 + 0.03\,RFC3 \\
&\quad (-0.32)\ (3.10)\ (4.27)\ (3.79)\ (7.70)\ (9.82)\ (6.25)\ (-0.44)\ (0.43)\ (0.04)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPPVG3} &= 0.004 - 0.01\,JS1 - 0.002\,JS2 - 0.01\,JS3 + 0.12\,\dot{PBOIL3} + 0.69\,\dot{RPPVG3}(-1) \\
&\quad (0.96)\ (-1.35)\ (-0.31)\ (-1.03)\ (2.59)\ (5.62)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPF03} &= 0.01 + 0.02\,JS1 + 0.01\,JS2 + 0.01\,JS3 + 0.09\,\dot{PSL4}(-1) - 0.04\,\dot{PBOIL3} - 0.01\,\dot{RFC3}(-1) - 0.06\,\dot{PSM2} - 0.38\,\dot{RPFA3}(-1) + 0.56\,\dot{RPF03}(-1) + 0.03\,\dot{ER34} \\
&\quad (0.50)\ (1.92)\ (1.70)\ (0.93)\ (3.41)\ (-0.56)\ (-0.24)\ (-1.83)\ (-0.88)\ (3.75)\ (0.13)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPSG3} &= -0.01 + 0.02\,JS1 + 0.06\,JS2 + 0.02\,JS3 + 0.35\,(\dot{PSG}(\dot{ER34})) + 0.04\,\dot{PBOIL3}(-1) + 0.37\,\dot{ER34}(-1) \\
&\quad (-0.51)\ (0.76)\ (2.00)\ (0.77)\ (8.89)\ (0.48)\ (0.54)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPKT3} &= 0.002 + 0.24\,(\dot{PKF}(-1)\,(\dot{ER34}(-1))) + 0.09\,\dot{PCDY3} + 0.52\,\dot{ER34} + 0.02\,\dot{PBOIL3} + 0.07\,\dot{IMPTE3} + 0.44\,\dot{RPKT3}(-1) - 0.01\,D77382 \\
&\quad (0.39)\ (10.46)\ (2.52)\ (2.37)\ (0.61)\ (2.66)\ (8.03)\ (-1.14)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPOF3} &= -0.01 + 0.52\,\dot{RPPVG3} + 0.28\,\dot{RPPFR3} - 0.01\,\dot{PBOIL3}(-1) + 0.01\,(\dot{PSG}(\dot{ER34})) + 0.40\,\dot{WA3} + 0.004\,\dot{RFC3} + 0.36\,\dot{RPOF3}(-1) \\
&\quad (-2.20)\ (3.48)\ (2.04)\ (-0.70)\ (1.63)\ (1.71)\ (0.25)\ (3.10)
\end{aligned}
$$

$$
\begin{aligned}
\dot{RPMD3} &= -7.01 + 0.06\,\dot{RPMT3}(-1) + 0.05\,XPWH3(-1) + 0.53\,\dot{RFC3}(-2) + 0.20\,\dot{WA3}(-1) - 0.001\,\dot{RPVG3}(-1) \\
&\quad (-4.90)\ (3.26)\ (2.88)\ (3.19)\ (12.60)\ (-0.12)
\end{aligned}
$$

$$
\begin{aligned}
LOG\,(\dot{RPFA3}) &= 0.02 + 0.13\,LOG\,(\dot{RPFH3}) + 0.07\,LOG\,(\dot{RPFH3}(-1)) + 0.03\,LOG\,(\dot{PBOIL3}) + 0.11\,LOG\,(\dot{WA3}) + 0.54\,LOG\,(\dot{RPFA3}(-1)) - 0.01\,LOG\,(TIME) + 0.02\,LOG\,(\dot{RFC3}(-1)) + 0.02\,LOG\,(\dot{PCDY3}(-1)) \\
&\quad (0.99)\ (2.44)\ (1.15)\ (2.82)\ (0.86)\ (5.41)\ (-0.97)\ (2.11)\ (1.29)
\end{aligned}
$$

$$
\begin{aligned}
LOG\,(\dot{RPFH3}) &= 0.003 - 0.005\,JS1 - 0.01\,JS2 - 0.004\,JS3 + 1.02\,(5.19\,LOG\,(\dot{RPMT3}) + 2.31\,LOG\,(\dot{RPDP3}) + 0.29\,LOG\,(\dot{RPEG3}) + 1.74\,LOG\,(\dot{RPCL3}) + 2.96\,LOG\,(\dot{RPFV3}) + 0.35\,LOG\,(\dot{RPF03}) + 0.25\,LOG\,(\dot{RPSG3}) \\
&\quad (3.67)\ (-4.07)\ (-4.58)\ (-2.97)\ (47.59) \\
&\quad + 0.61\,LOG\,(\dot{RPKT3}) + 1.61\,LOG\,(\dot{RPOF3}) + 0.24\,LOG\,(\dot{RPMD3}))\ /\ 15.55
\end{aligned}
$$

$$
\begin{aligned}
LOG\,(\dot{RPF03}) &= -0.002 + 1.08\,(15.55\,LOG\,(\dot{RPFH3}) + 5.56\,LOG\,(\dot{RPFA3}))\ /\ 21.11 \\
&\quad (-4.69)\ (87.93)
\end{aligned}
$$

* Coefficients appearing in this table are estimated in the range 1971Q1 to 1982Q4. Student statistics are in brackets.

REGRESSION STATISTICS

	R^2	D.W.	F
RPBF3	0.89	2.02	26.54
RPPK3	0.93	2.11	65.83
RPEG3	0.96	2.32	85.46
RPCK3	0.80	2.18	12.97
RPTK3	0.62	2.20	6.03
RPMT3	0.99	1.49	1019.04
RPFM3	0.99	1.14	5783.21
RPIC3	0.99	1.90	1210.97
RPCB3	0.99	2.12	4.89 E+04
RPMG3	0.99	1.04	2490.70
RPPC3	0.99	2.16	9383.61
RPPM3	0.99	1.65	5931.87
RPEM3	0.99	0.92	8280.89
RPDP3	0.99	2.23	5421.02
RPCL3	0.99	1.58	7278.74
RPAP3	0.92	1.10	43.78
RPBN3	0.99	1.97	768.76
RPOR3	0.97	0.60	110.15
RPFR3	0.99	1.10	2424.17
RPPFR3	0.99	1.83	6818.57
RPLET3	0.98	2.07	289.30
RPPW3	0.93	2.77	57.28
RPTT3	0.98	1.77	174.96
RPVG3	0.99	1.18	502.76
RPPVG3	0.70	1.85	10.10
RPFO3	0.74	1.96	5.75
RPSG3	0.69	1.78	15.11
RPKT3	0.91	2.42	54.40
RPOF3	0.71	2.12	13.04
RPMO3	0.99	0.72	972.27
RPFM3	0.99	1.34	789.09
RPFA3	0.70	2.26	11.14
RPFD3	0.99	1.22	7731.57

TABLE 2

Symbols and Definition of the Variables Used
in the Revised Version of the CPI-Food Forecasting Model

ENDOGENOUS VARIABLES

RPAP3	- CPI for apples, Canada (1971=100)
RPBF3	- CPI for beef, Canada (1971=100)
RPBN3	- CPI for bananas, Canada (1971=100)
RPCB3	- CPI for butter, Canada (1971=100)
RPCK3	- CPI for chicken, Canada (1971=100)
RPCL3	- CPI for cereal and bakery products, Canada (1971=100)
RPDP3	- CPI for dairy products, Canada (1971=100)
RPEG3	- CPI for eggs, Canada (1971=100)
RPEM3	- CPI for evaporated milk, Canada (1971=100)
RPFA3	- CPI for food away from home, Canada (1971=100)
RPFD3	- CPI for food, Canada (1971=100)
RPFH3	- CPI for food for home consumption, Canada (1971=100)
RPFM3	- CPI for fluid milks, Canada (1971=100)
RPFO3	- CPI for fats and oils (excluding butter), Canada (1971=100)
RPFR3	- CPI for fresh fruit, Canada (1971=100)
RPFV3	- CPI for fruit and vegetables, Canada (1971=100)
RPIC3	- CPI for ice cream, Canada (1971=100)
RPKT3	- CPI for coffee and tea, Canada (1971=100)
RPLET3	- CPI for lettuce, Canada (1971=100)
RPMD3	- CPI for prepared and partially prepared main dishes, Canada (1981=100)
RPMG3	- CPI for margarine, Canada (1971=100)
RPMT3	- CPI for meat, poultry and fish, Canada (1971=100)
RPOF3	- CPI for other food purchased from stores, Canada (1971=100)
RPOR3	- CPI for oranges, Canada (1971=100)
RPPC3	- CPI for processed cheese, Canada (1971=100)
RPPFR3	- CPI for processed fruit, Canada (1971=100)
RPPK3	- CPI for pork, Canada (1971=100)
RPPM3	- CPI for skim-milk powder, Canada (1971=100)
RPPVG3	- CPI for processed vegetables, Canada (1971=100)
RPPW3	- CPI for potatoes, Canada (1971=100)
RPSG3	- CPI for sugar and sugar preparation, Canada (1971=100)
RPTK3	- CPI for turkeys, Canada (1971=100)
RPTT3	- CPI for tomatoes, Canada (1971=100)
RPVG3	- CPI for fresh vegetables, Canada (1971=100)

EXOGENOUS VARIABLES

FARM AND WHOLESALE PRICES

3	AFPLET3	- Annual implicit average farm price of lettuce, Canada ($/lb)
3	IMPAP3	- Unit import value for apples, Canada (cents/lb)
3	IMPBN3	- Unit import value for bananas, Canada (cents/lb)
3	IMPLET3	- Unit import value for lettuce, Canada (cents/lb)
3	IMPOR3	- Unit import value for oranges, Canada (cents/lb)
3	IMPPW3	- Unit import value for potatoes, Canada (cents/lb)
3	IMPTE3	- Unit import value for tea, Canada (cents/lb)
3	IMPTT3	- Unit import value for tomatoes, Canada (cents/lb)
1	PHG2	- Price index 100 hogs, Ontario ($/cwt)
3	PUF	- Indicator price of coffee under the 1976 International Coffee Agreement (U.S. cents/lb)
3	PSG	- Indicator price of sugar under the 1977 International Sugar Agreement (U.S. cents/lb)
4	PSL4	- Price of soybean oils, U.S. ($/t)
1	PSM2	- Price of soybean meal, eastern Canada ($/t)
1	WPCH3	- Wholesale price of cheddar cheese (Belleville), Canada ($/kg)
1	WPEM3	- Industrial selling price index for evaporated milk, Canada (1971=100)
1	WPIC3	- Industrial selling price index for ice cream, Canada (1971=100)

3	WPPW3	- Wholesale price of domestic potatoes, Canada ($/lb)
1	WPSS2	- Wholesale price of steer carcasses (A1), Toronto ($/cwt)
1	XPCU3	- Average price to producers for broiler chicken, Toronto (cents/lb)
1	XPEG3	- Average price to producers for Grade A large eggs, Toronto (cents/doz)
1	XPFM3	- Average farm price for fluid milk, Canada ($/hL)
1	XPTK3	- Average weighted price for turkey to producers, Toronto (cents/lb)
1	XPWH3	- Cost of wheat to domestic millers, Canada ($/t)
1	XWPCB3	- Wholesale support price of butter, Canada ($/kg)
1	XWPPM3	- Wholesale support price of skim milk powder, Canada ($/kg)

DISAPPEARANCE AND SUPPLY VARIABLES

1	DCK3	- Disappearance of chicken, Canada (mil. kg)
1	DLM	- Disappearance of low fat milk, Canada (mil. L)
1	TDSTK3	- Total domestic supply of turkey, Canada

MACROECONOMIC AND COST VARIABLES

2	ER34	- Canada - U.S. Exchange rate ($ Can/$ U.S.)
2	PBOIL3	- Blended Price of crude oil, Canada ($/bbl)
2	PCDY3	- Per capita disposable income, Canada
2	RFC3	- Rate on 90-day finance company paper, Canada
2	RPEN3	- Retail price index for energy, Canada (1971=100)
1,2	WAPK3	- Average weekly earning in the slaughtering and meat processing industry, Canada ($)
2	WA3	- Average weekly earning - industrial composite, Canada ($)

OTHER

D77382	-	Dummy variable for structural change in coffee pricing (1977 Q3 to date)
D7782	-	Dummy variable for structural change in the lettuce market (1977 to date)
D81Q3	-	Dummy variable for reduction of domestic (Ontario) seeded area
D82	-	Dummy variable for effect of foot-and-mouth disease in Denmark (1982 Q1 and Q2)
D8201	-	Dummy variable for export deal to Cuba (2 Mkg)
D82Q2	-	Dummy variable for liquidation of chicken stocks at reduced prices
JS1	-	Seasonal dummy, first quarter
JS2	-	Seasonal dummy, second quarter
JS3	-	Seasonal dummy, third quarter
JS4	-	Seasonal dummy, fourth quarter
JS123	-	Seasonal dummy, first, second and third quarters
TIME		Linear time trend
XCSUM3		Consumer subsidy on fluid milk (from 1973 Q4 to 1974 Q3), Canada
XCSUP3		Consumer subsidy on skim milk powder, Canada ($/kg)

note: a) The numbers on the left-hand side of the symbols for the exogenous variables indicate the source of forecast values.

1 = the model FARM
2 = the Conference Board of Canada
3 = Agriculture Canada commodity analysts
4 = Chase Econometrics

b) A dot over a variable symbol means that the variable is transformed into a rate of change or a relative change.

Problems encountered

The major problem in the construction of the revised CPI-Food forecasting model has been to reconcile the explanatory power and the forecasting abilities of the model. Some coefficients did not have a high degree of significance in OLS estimation, but were useful in generating an accurate forecast. The changes in retail pork prices helped forecast retail beef prices as long as the t-statistic was lower than 0.5; similarly, the changes in the proxy for energy cost helped in forecasting the retail sugar and confection price index, despite a high standard error associated with the coefficient. This difficult reconciliation would have been straightforward or much simpler if a three-stage least squares estimation had been used, considering the likely hypothesis of residuals correlated across equations.

The second problem in the construction of the model relates to the availability of forecasting sources for compatible explanatory variables. The proxy for energy costs of food processing, distribution and retailing may be too broad for these costs. The lack of forecast mark-ups also weakens the set of explanatory variables. The lack of packaging price forecast has probably also weakened the explanatory power of some equations in the model. At the processing level, in 1980 packaging expenditures represented more than 17% of expenditures on materials and supplies for fruit and vegetable canners, the

frozen fruit and vegetable industries, biscuit manufacturers and confectioners.

Some results have caused interpretation difficulties, mainly those derived from the beef and pork price equations. For the retail pork price equation, the high estimated elasticity (0.41) of the retail pork price with respect to the Canada-U.S. exchange rate has caused some concern. Further research was carried out to explain this high responsiveness to the exchange rate (see Appendix I). The results supported the argument that a lower Canadian dollar can stimulate pork exports sufficiently to reduce the supply to the domestic retail market and subsequently to increase significantly the domestic retail price.

Finally, in simulation a problem occured for the retail beef price equation. When interest rates were very high in the summer of 1981, consumers did not react to the seasonal increase in per capita disposable income. That is, the demand for beef did not move up as it would have done under better economic conditions. This situation has been studied and the above explanation was statistically captured by a dummy variable which interacts with the per capita disposable income variable. This difficulty raised the need for an assumption on the temporariness of this consumer reaction. In fact, the assumption embedded in the model predicts that consumers will in the near future return to their earlier behavior pattern in regard to beef demand and seasonality in disposable income.

Evaluation of Individual Equation Forecasts

The extra-sample ex-post validation measures listed in Table 3 (page 39) assess the quality of the forecast resulting from both the revised and new equations of the model.(16) All these measures indicate significant improvements compared to the current equations' simulation results.

All the mean percentage errors are under 1% in absolute terms, except for some fruit and vegetable equations, and the other food purchased from stores and food purchased from restaurants equations.

The largest Theil's inequality coefficients occur for fresh fruits and vegetables, coffee and tea and other food purchased from stores. The fresh fruit and vegetables component is more difficult to forecast because of the sensitivity of these products to labour disputes, and transportation and weather problems. Non-price competition (differences in quality and in any form of advertising) in fruit and vegetables, beverages, and miscellaneous food markets also impedes the modeling of these pricing processes.(17)

The following graphs (pages 40-49) provide further evidence of the quality of the simulation results. The result of the current equations are shown for comparison purposes. The average improvement in the quarterly tracking capability of the forecasting equations is easily seen.

TABLE 3

Validation Measures for Selected Equations of the CPI-Food Forecasting Models

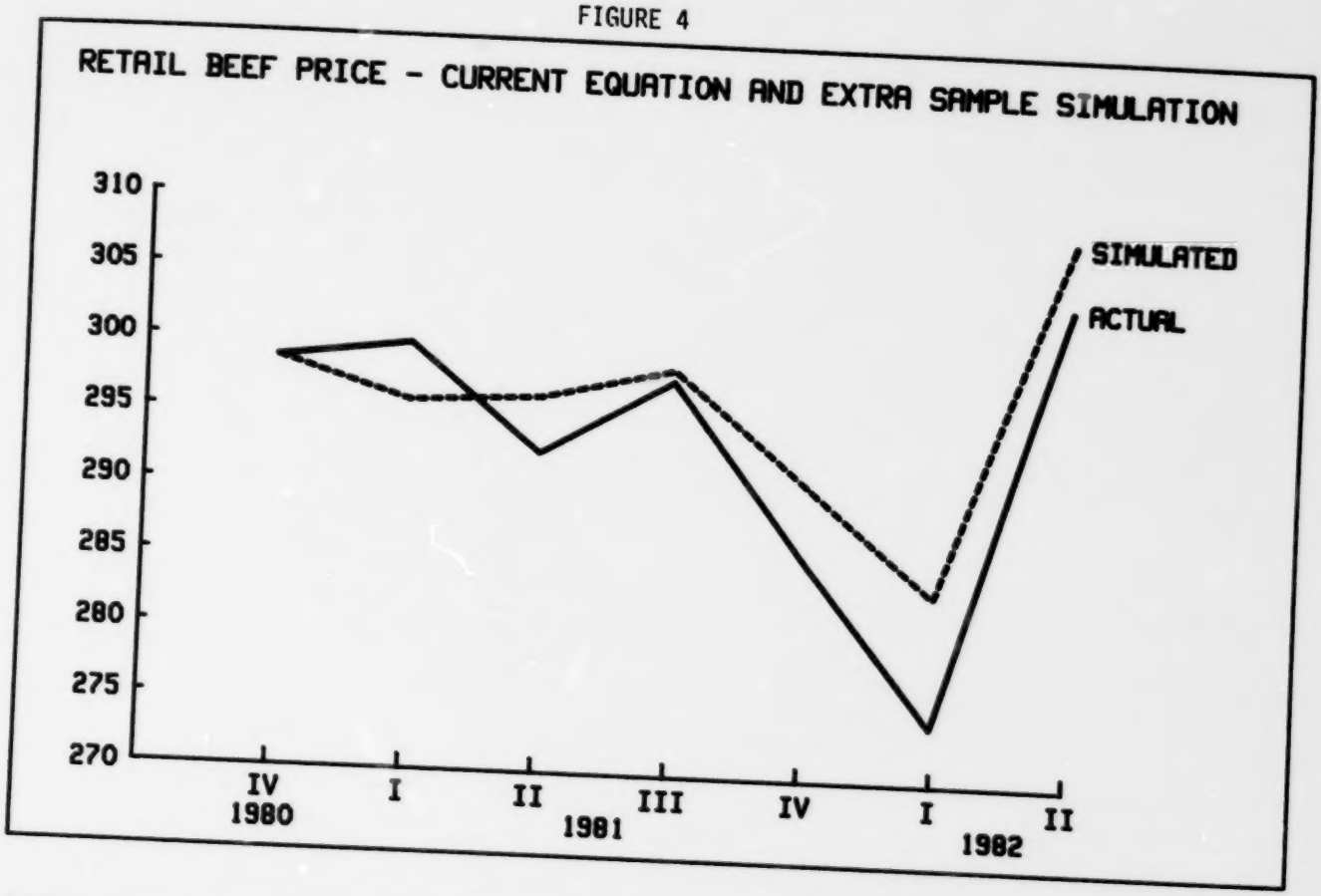
EXTRA-SAMPLE SIMULATION 1981 Q1 TO 1982 Q2

CPI	MPE		RMSPE		THEIL*	
	CURRENT	REVISED	CURRENT	REVISED	CURRENT	REVISED
beef	1,15	0,36	1,84	1,07	0,018	0.011
pork	2,20	-0,52	2,85	0,76	0,028	0.007
chicken	0,13	0,99	2,96	1,50	0,030	0,015
turkey	1,98	-0,63	2,80	2,84	0,027	0,028
eggs	-3,88	-0,65	3,96	0,84	0,040	0,008
oranges	18,53	8,87	18,95	9,84	0,188	0,103
bananas	5,25	1,41	6,37	2,36	0,065	0,024
processed veg.	-6,76	1,08	8,00	1,32	0,086	0,016
lettuce	5,14	-0,24**	11,55	3,49**	0,106	0,036**
potatoes	-11,25	-2,12	17,30	3,14	0,199	0,033
fats and oils	-1,19	-0,51	1,55	1,01	0,138	0,01
sugar&sugar prep.	12,26	-2,85	13,08	4,85	0,126	0,046
coffee and tea	-1,13	0,28	1,99	2,01	0,020	0,020
other foods	NA	1,48	NA	2,65	NA	0,027
prep. and partially prep. main dishes	NA	0,21	NA	1,68	NA	0,018
food purchased from restaurants	1,80	1,54	2,10	1,86	0,021	0,019

* Theil's inequality coefficient

** Simulation Period: 1980 Q4 TO 1981 Q4; this different period is due to the unavailability of data at time of validation

FIGURE 4


RETAIL BEEF PRICE - CURRENT EQUATION AND EXTRA SAMPLE SIMULATION
310
305
300
295
290
285
280
275
270
SIMULATED
ACTUAL
IV
1980
I
II
III
1981
IV
I
1982
II

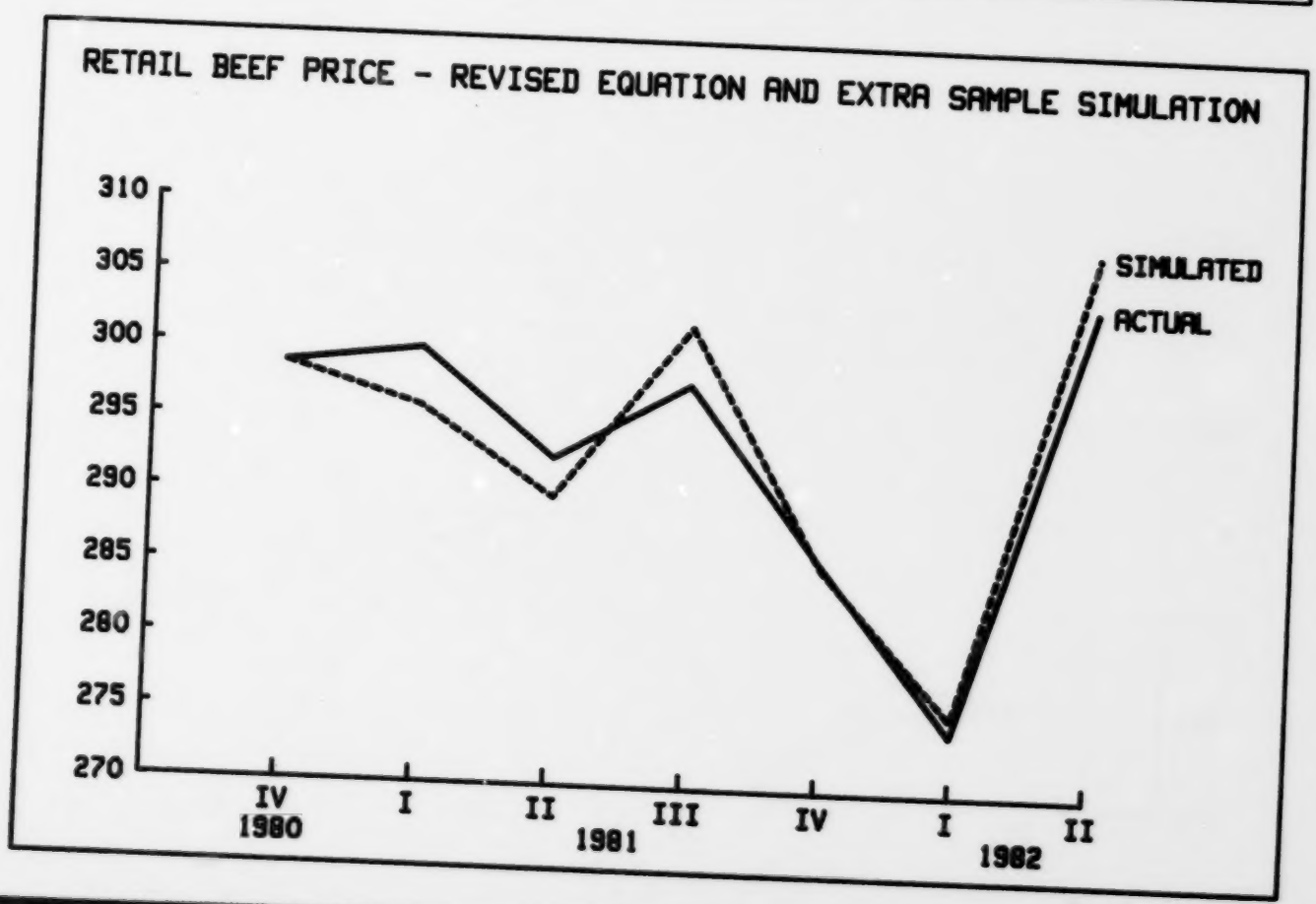
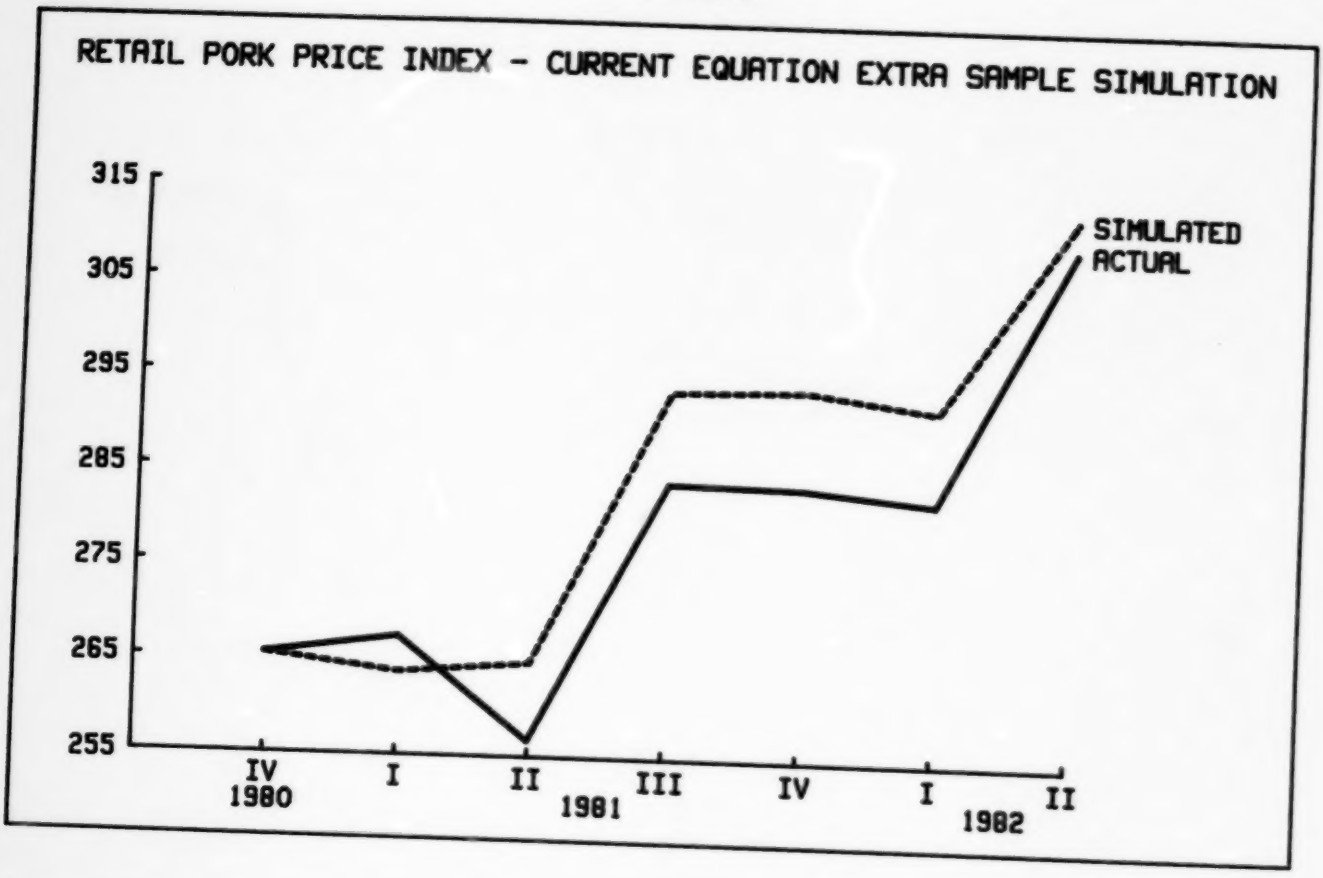

RETAIL BEEF PRICE - REVISED EQUATION AND EXTRA SAMPLE SIMULATION
310
305
300
295
290
285
280
275
270
SIMULATED
ACTUAL
IV
1980
I
II
III
1981
IV
I
1982
II

FIGURE 5


RETAIL PORK PRICE INDEX - CURRENT EQUATION EXTRA SAMPLE SIMULATION
315
305
295
285
275
265
255
SIMULATED
ACTUAL
IV
1980
I
II
III
1981
IV
I
1982
II

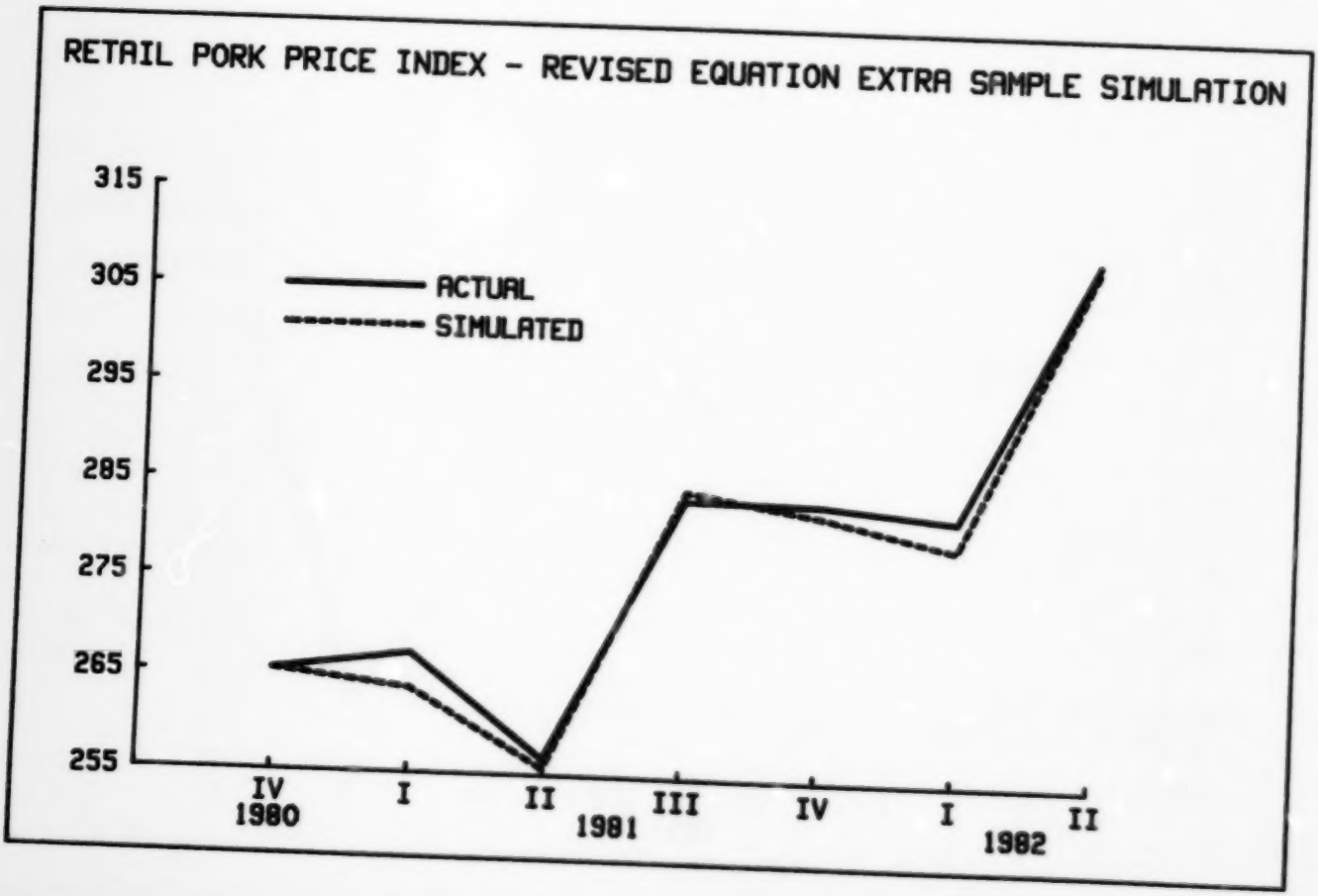
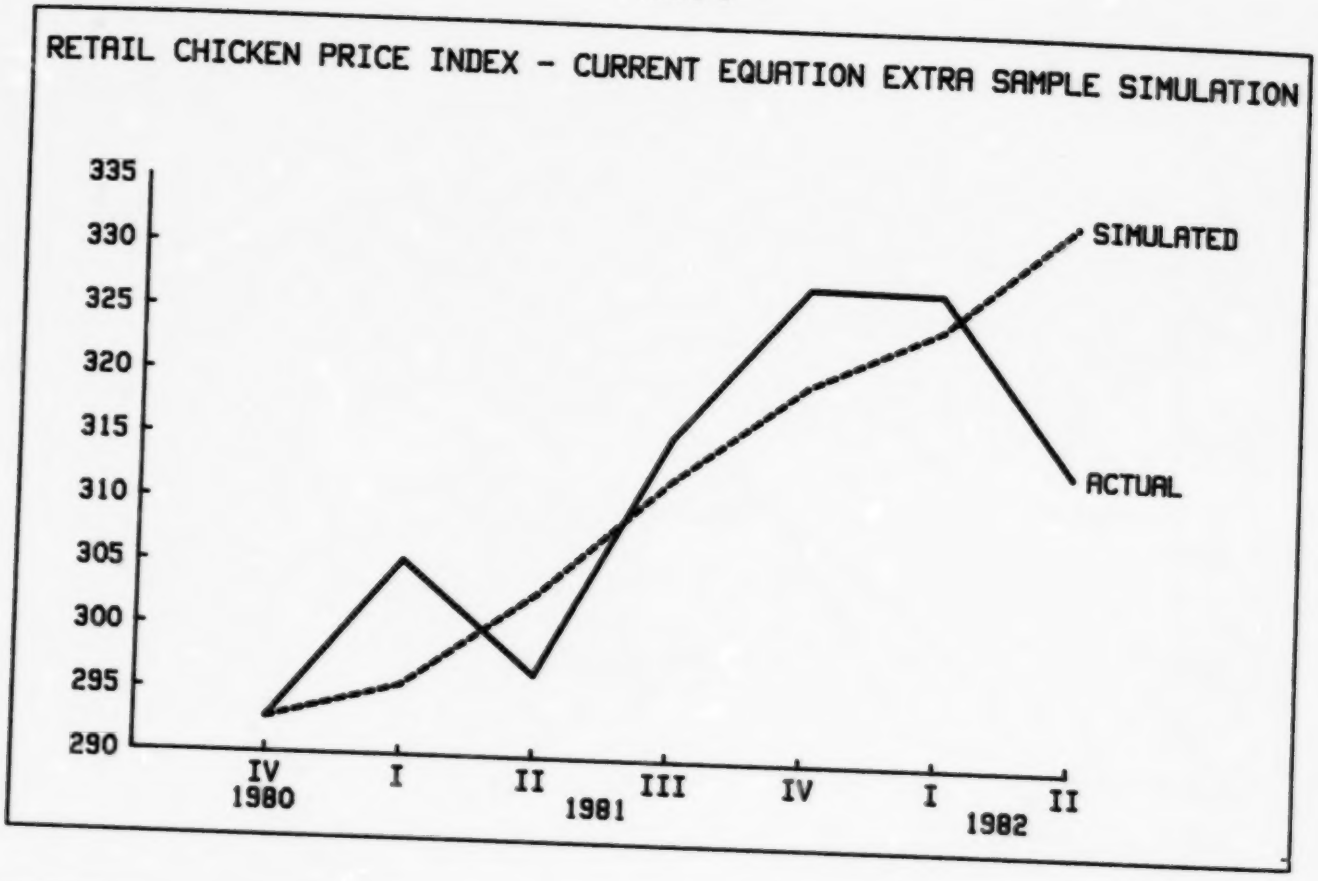

RETAIL PORK PRICE INDEX - REVISED EQUATION EXTRA SAMPLE SIMULATION
315
305
295
285
275
265
255
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

FIGURE 6


RETAIL CHICKEN PRICE INDEX - CURRENT EQUATION EXTRA SAMPLE SIMULATION
335
330
325
320
315
310
305
300
295
290
SIMULATED
ACTUAL
IV
1980
I
II
III
IV
I
II
1981
1982

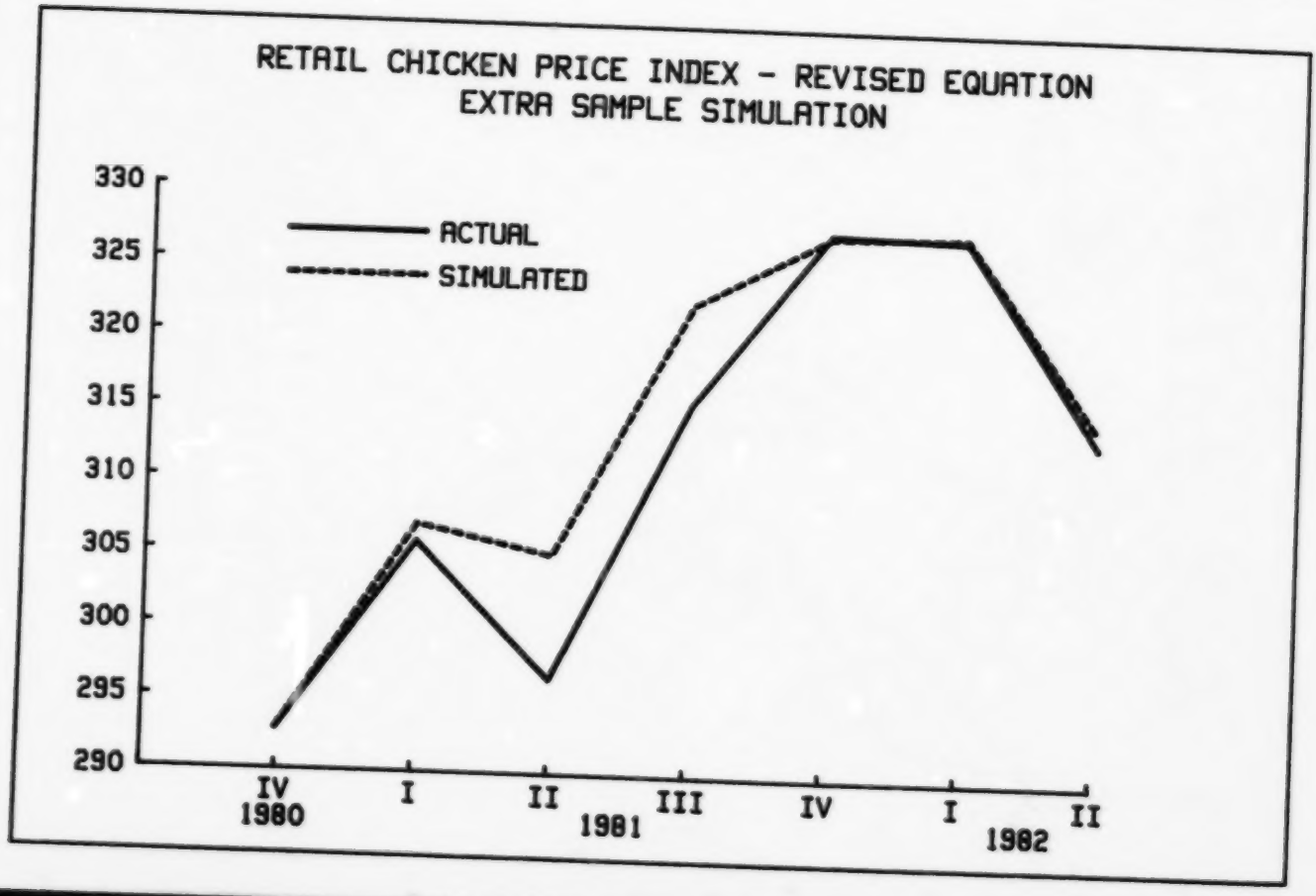
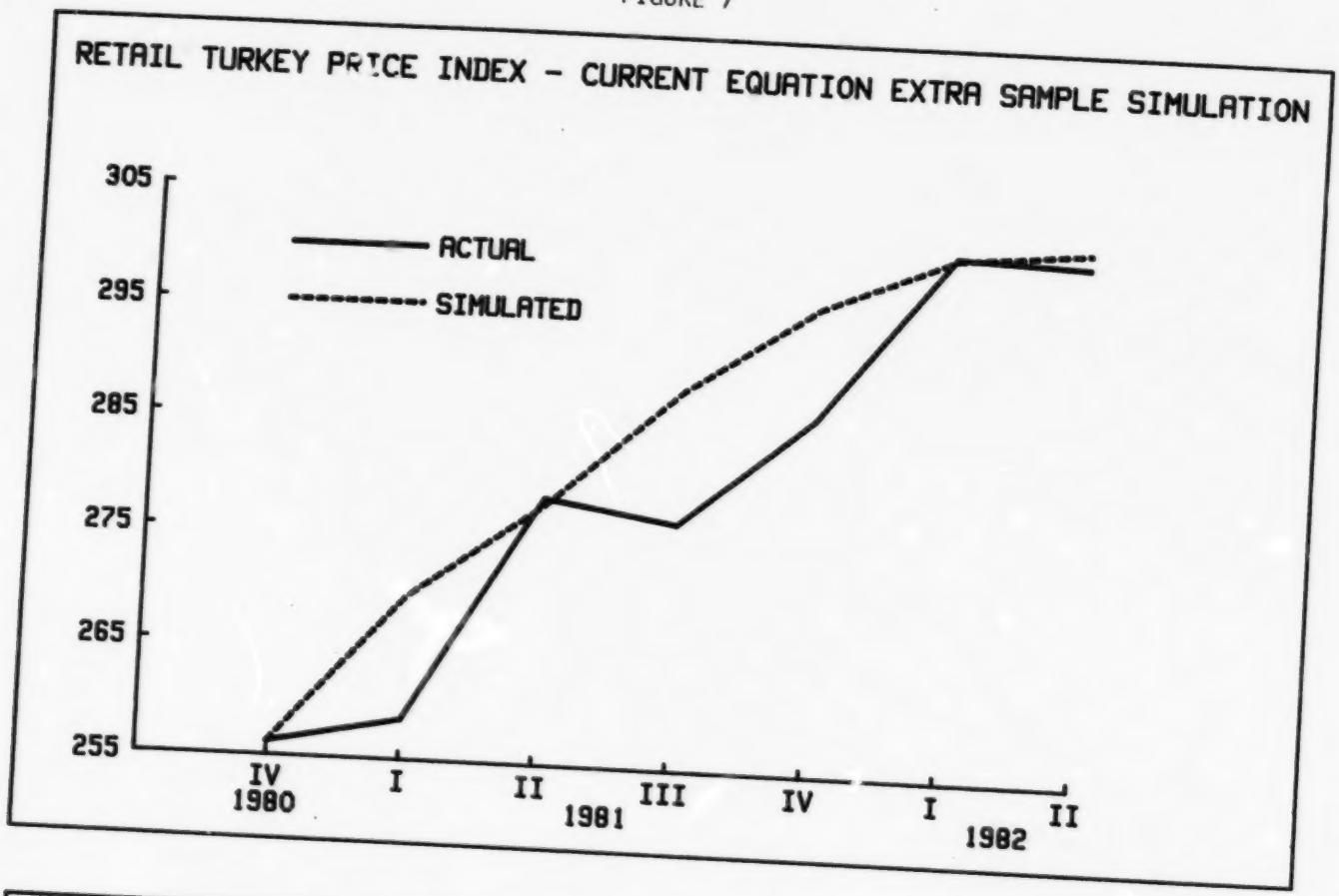

RETAIL CHICKEN PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
330
325
320
315
310
305
300
295
290
ACTUAL
SIMULATED
IV
1980
I
II
III
IV
I
II
1981
1982

FIGURE 7


RETAIL TURKEY PRICE INDEX - CURRENT EQUATION EXTRA SAMPLE SIMULATION
305
295
285
275
265
255
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

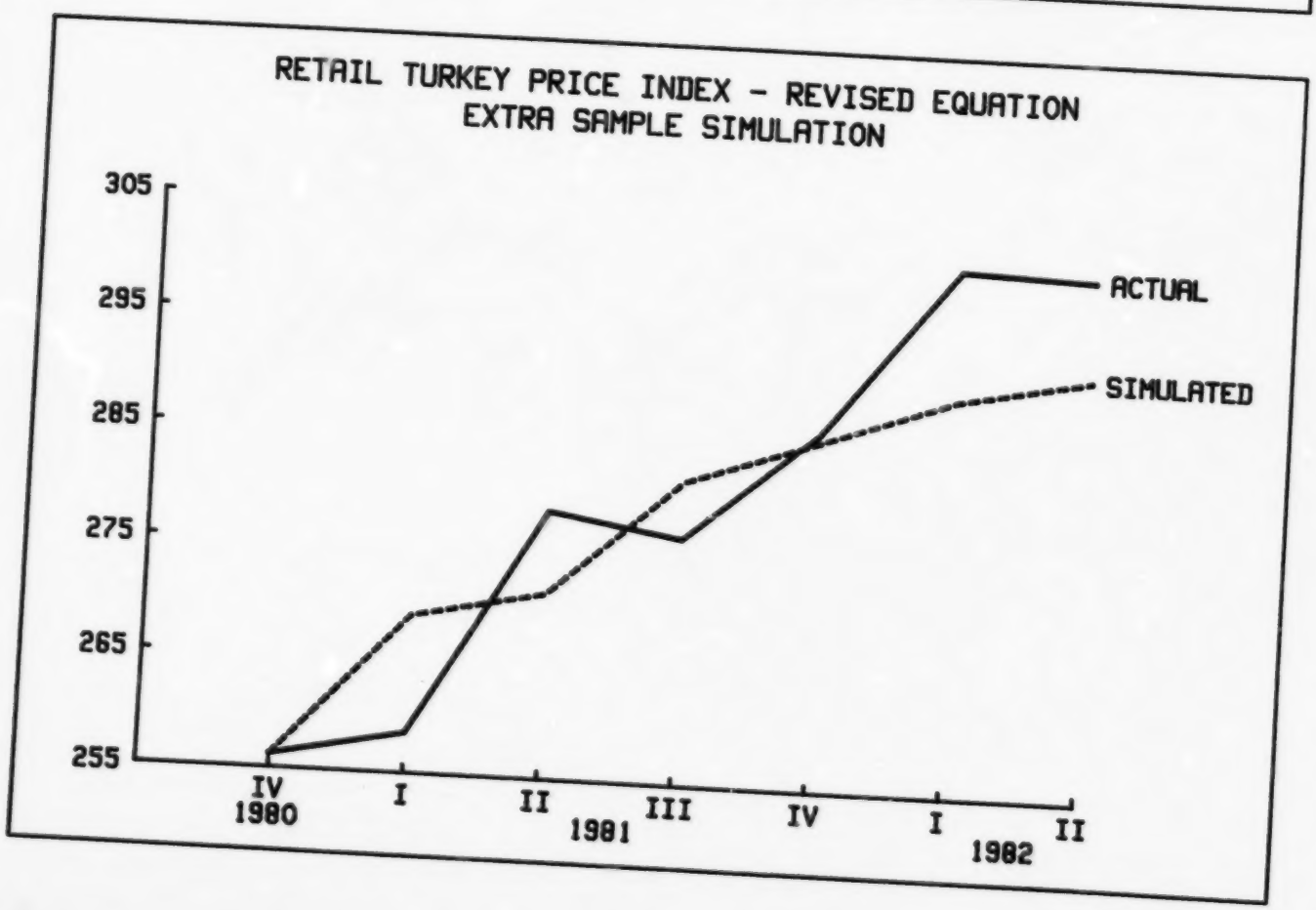
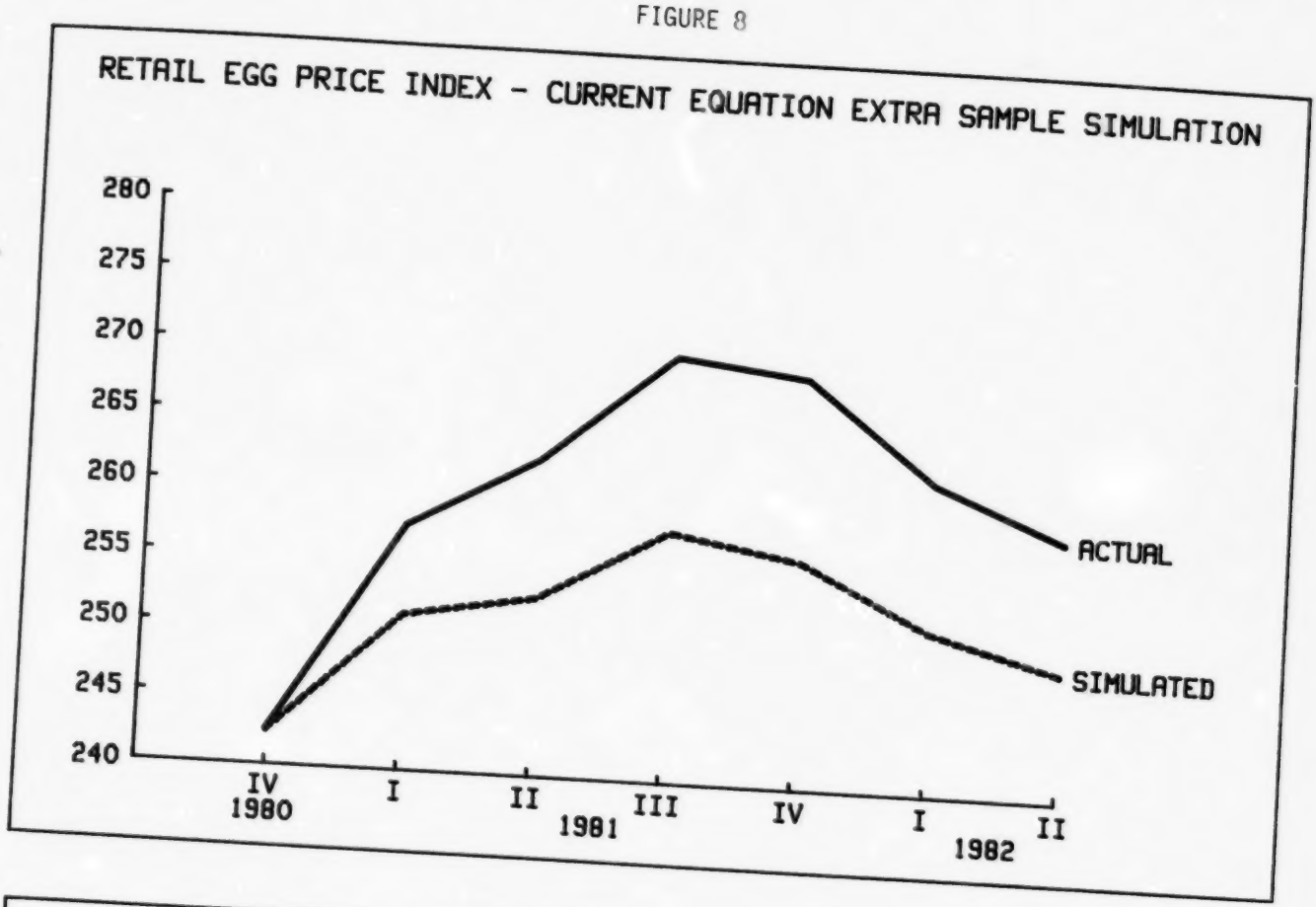

RETAIL TURKEY PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
305
295
285
275
265
255
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

FIGURE 8


RETAIL EGG PRICE INDEX - CURRENT EQUATION EXTRA SAMPLE SIMULATION
280
275
270
265
260
255
250
245
240
ACTUAL
SIMULATED
IV
1980
I
II
1981
III
IV
I
1982
II

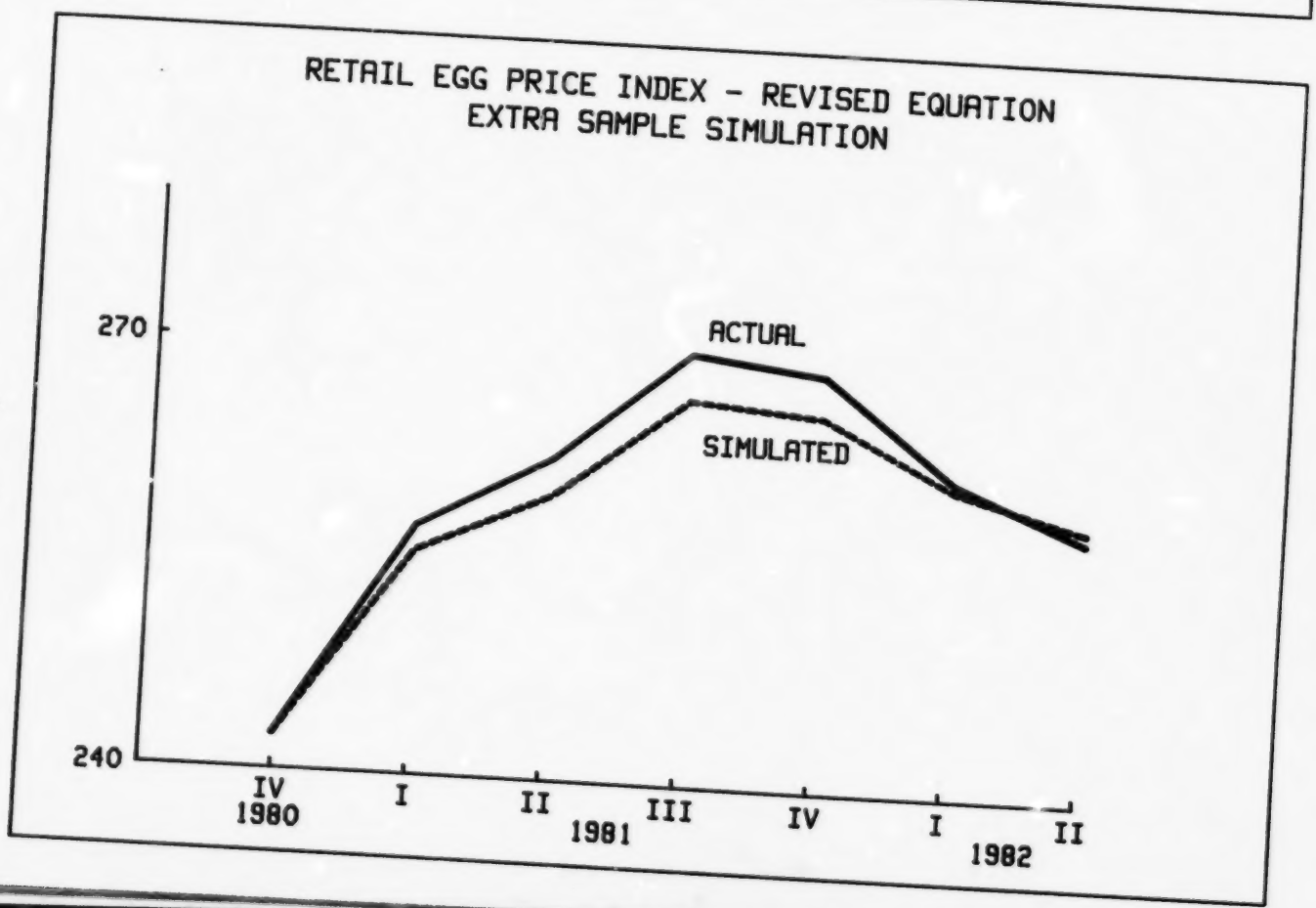
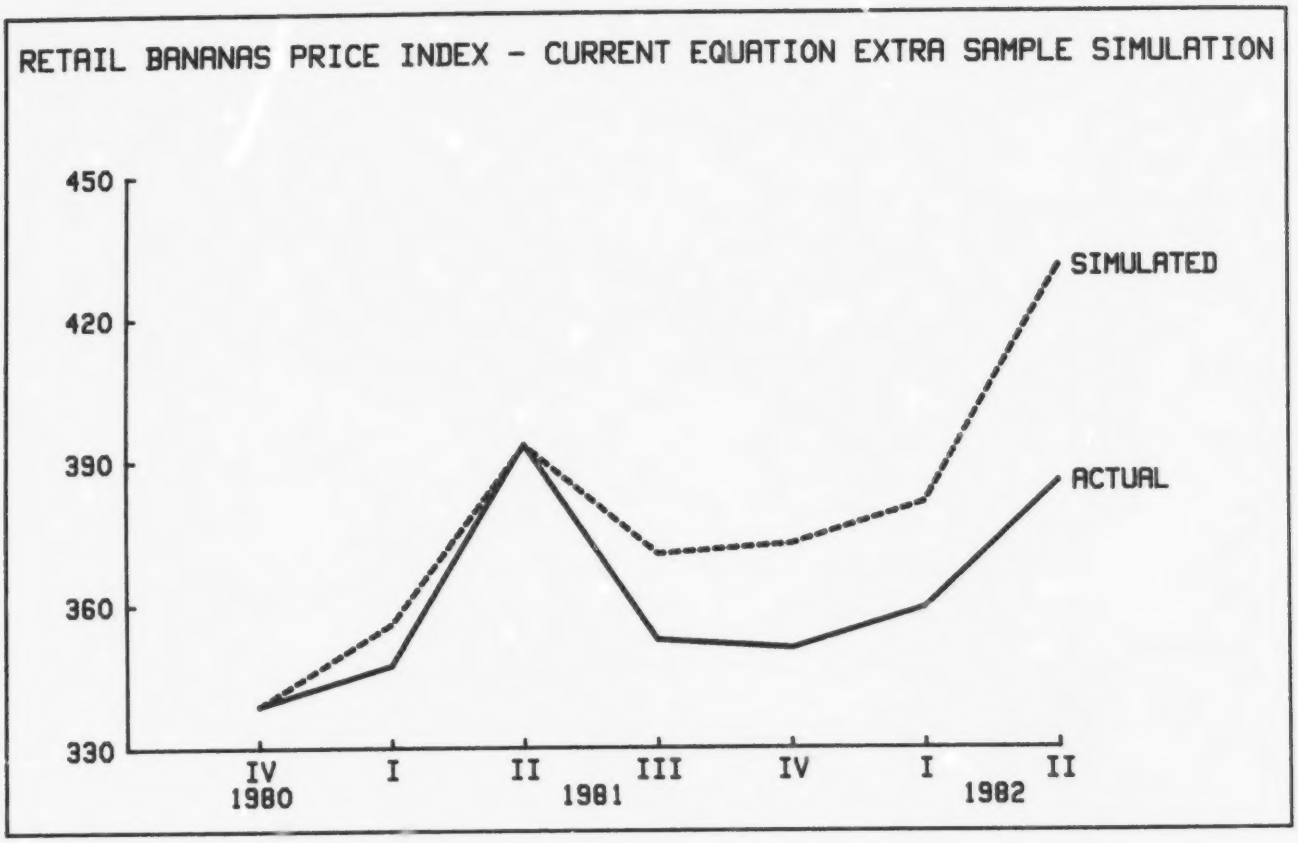

RETAIL EGG PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
270
240
ACTUAL
SIMULATED
IV
1980
I
II
1981
III
IV
I
1982
II

FIGURE 9


RETAIL BANANAS PRICE INDEX - CURRENT EQUATION EXTRA SAMPLE SIMULATION
450
420
390
360
330
SIMULATED
ACTUAL
IV
1980
I
II
III
1981
IV
I
1982
II

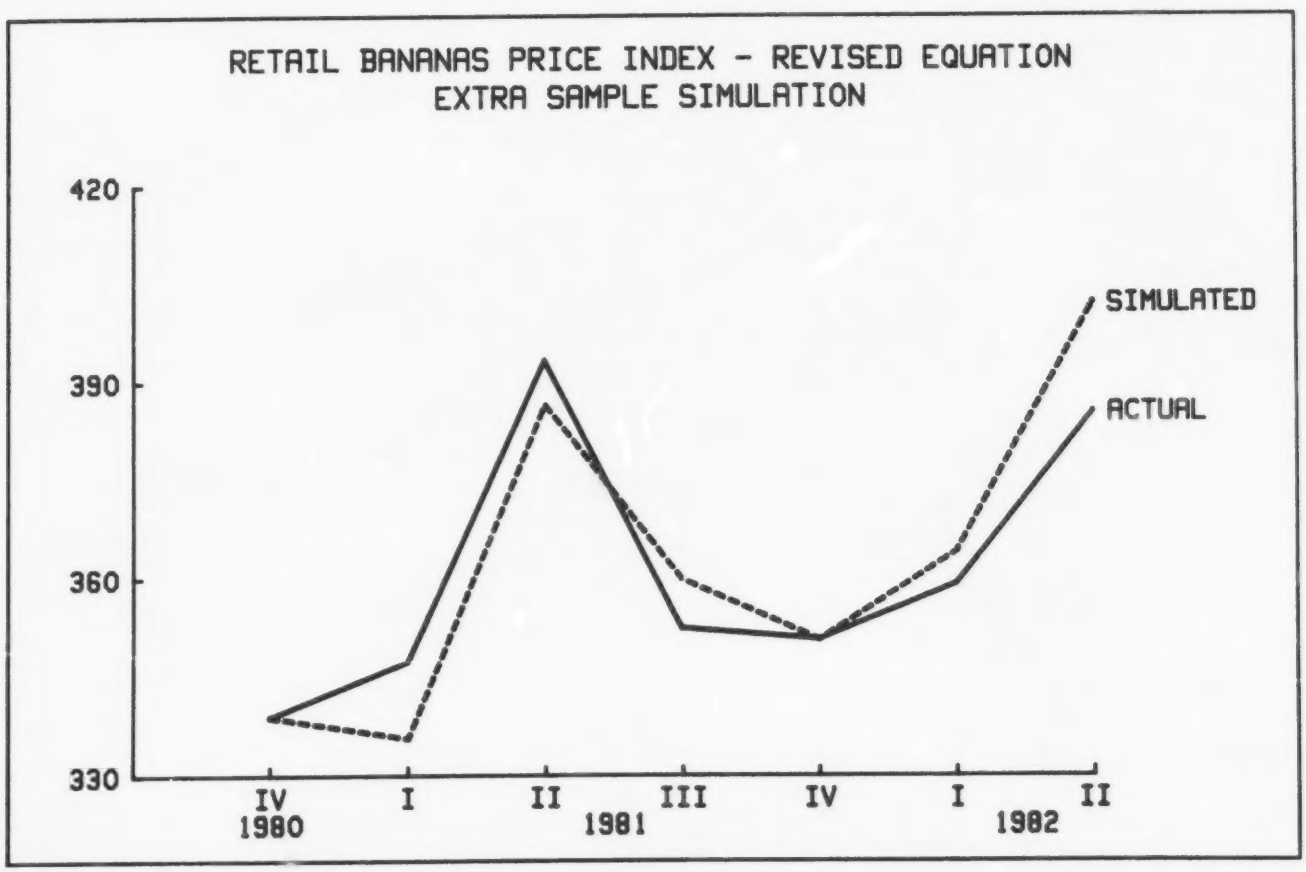
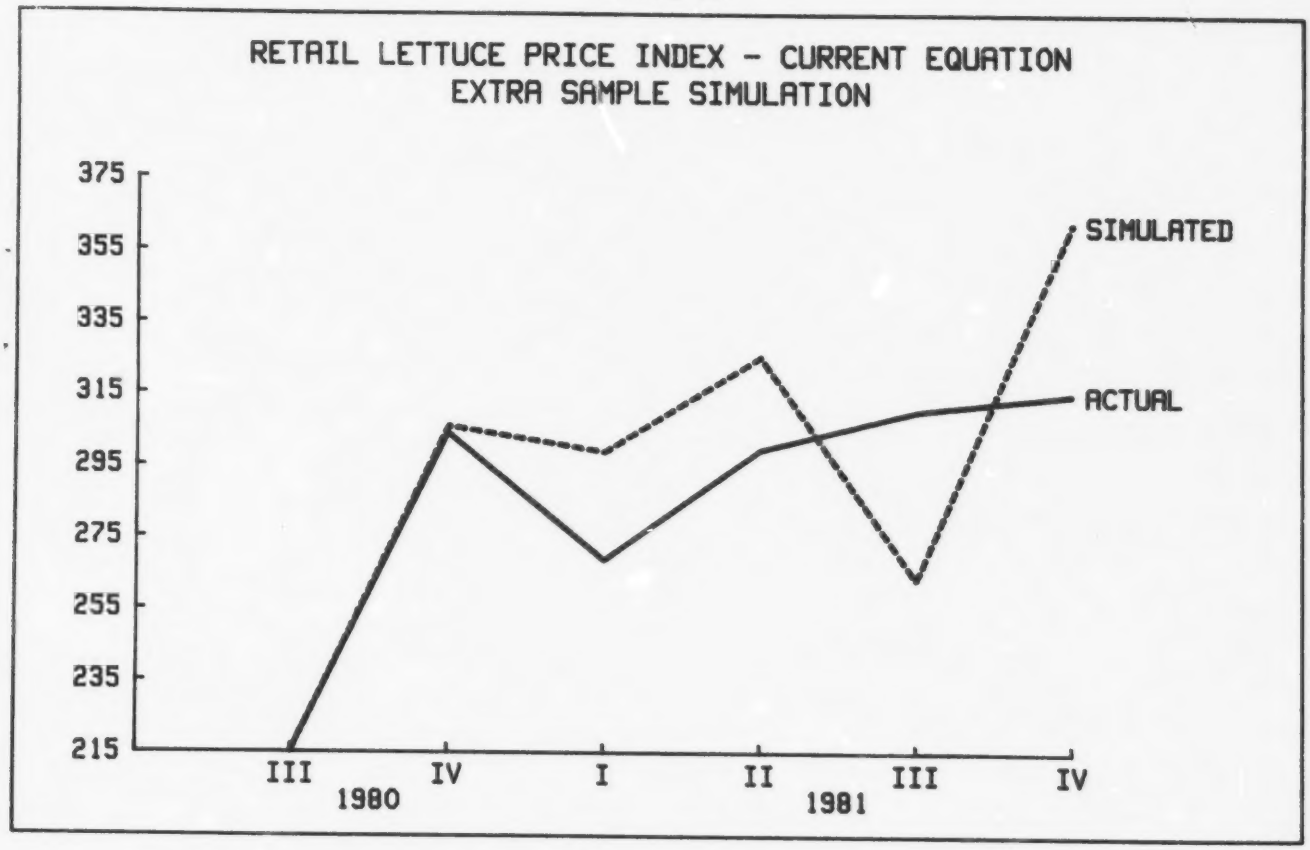

RETAIL BANANAS PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
420
390
360
330
SIMULATED
ACTUAL
IV
1980
I
II
III
1981
IV
I
1982
II

FIGURE 10


RETAIL LETTUCE PRICE INDEX - CURRENT EQUATION
EXTRA SAMPLE SIMULATION
375
355
335
315
295
275
255
235
215
SIMULATED
ACTUAL
III
IV
I
II
III
IV
1980
1981

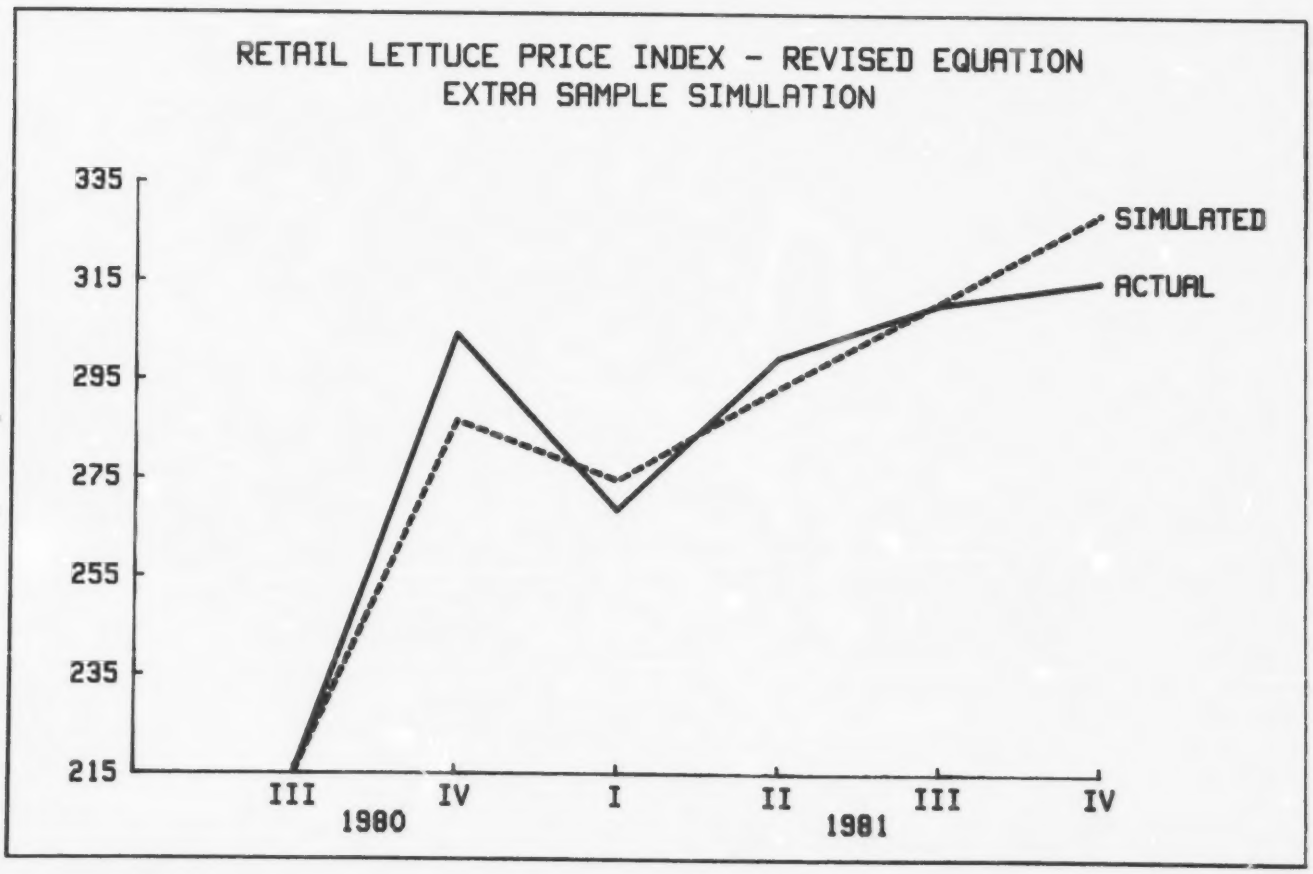
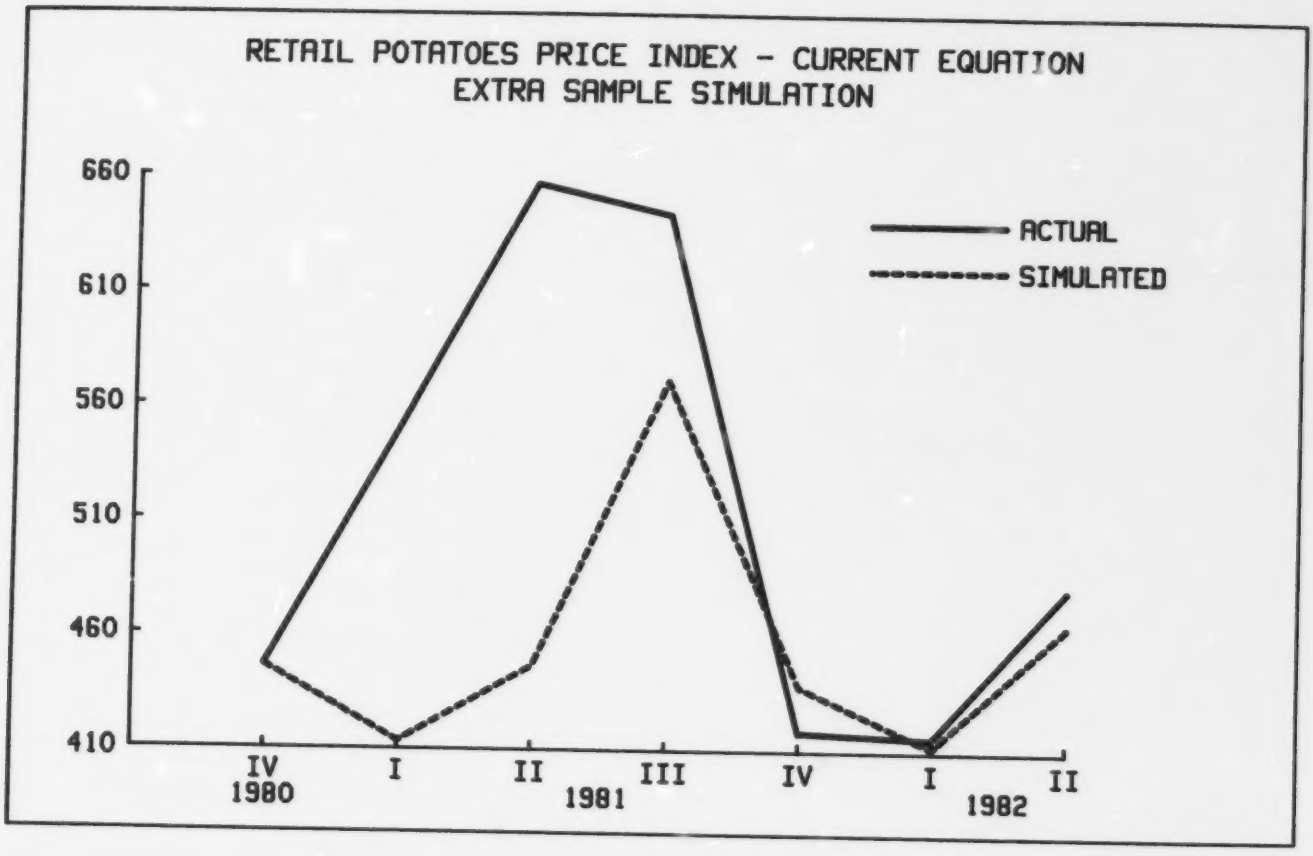

RETAIL LETTUCE PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
335
315
295
275
255
235
215
SIMULATED
ACTUAL
III
IV
I
II
III
IV
1980
1981

FIGURE 11


RETAIL POTATOES PRICE INDEX - CURRENT EQUATION
EXTRA SAMPLE SIMULATION
660
610
560
510
460
410
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

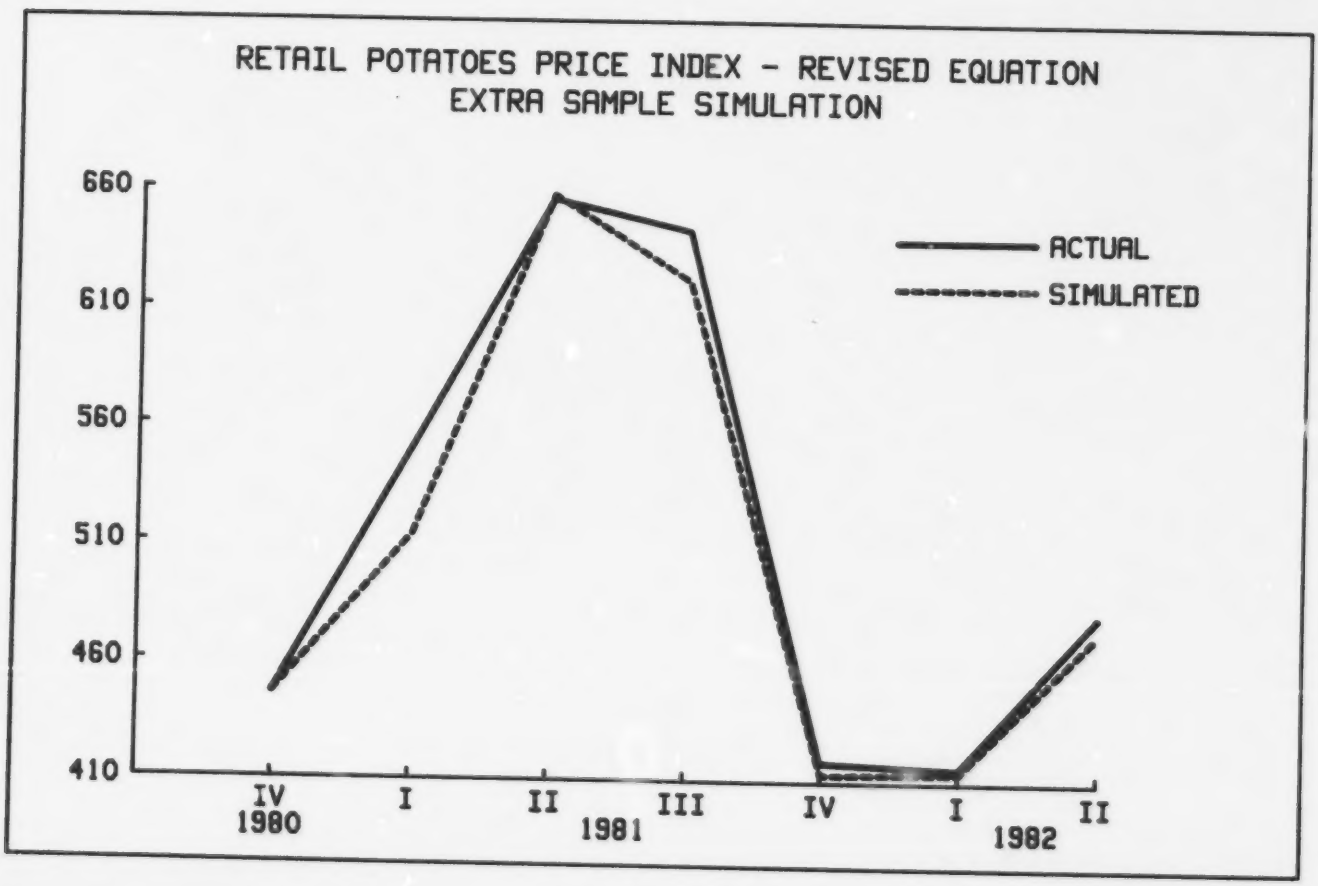
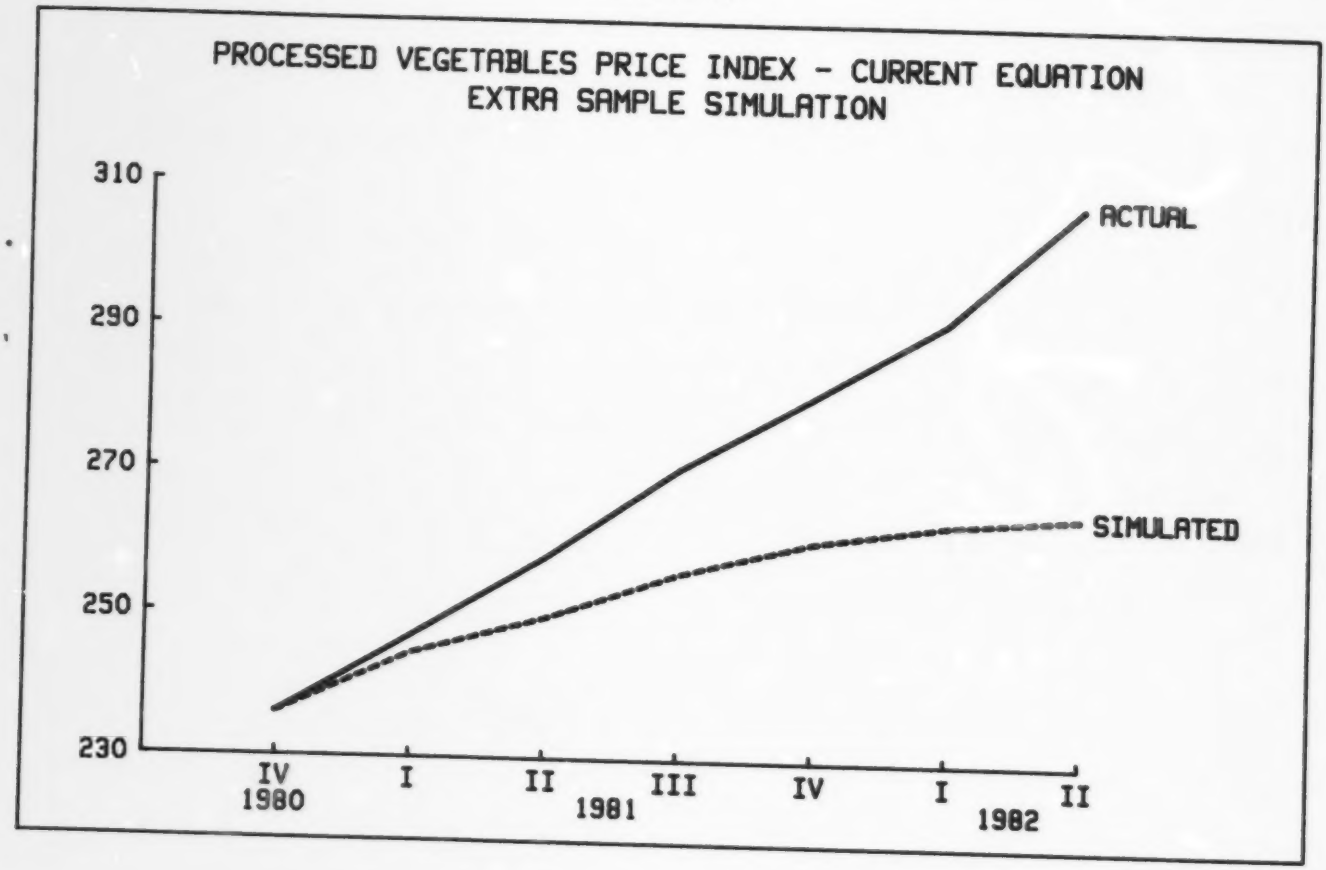

RETAIL POTATOES PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
660
610
560
510
460
410
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

FIGURE 12


PROCESSED VEGETABLES PRICE INDEX - CURRENT EQUATION
EXTRA SAMPLE SIMULATION
310
290
270
250
230
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

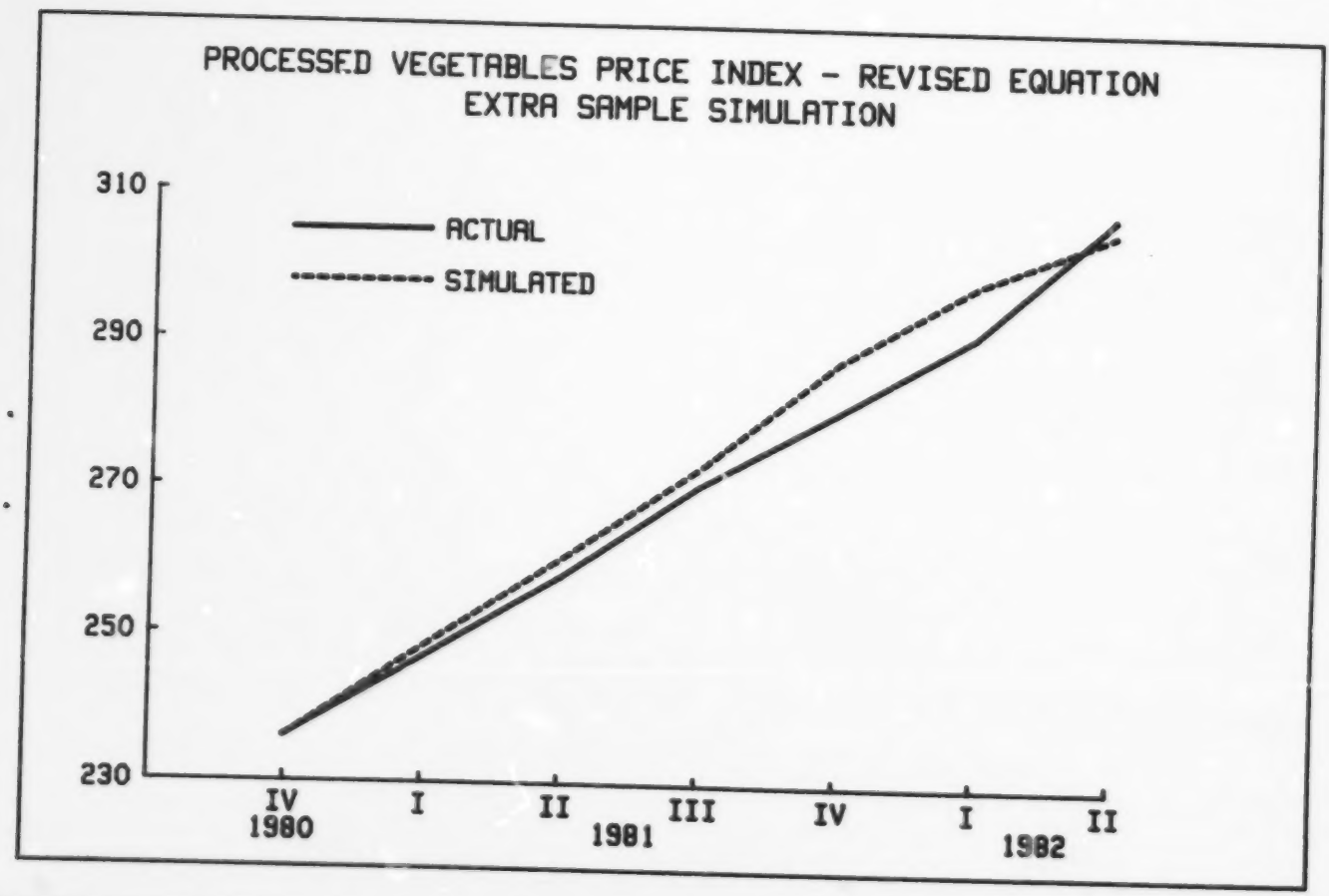
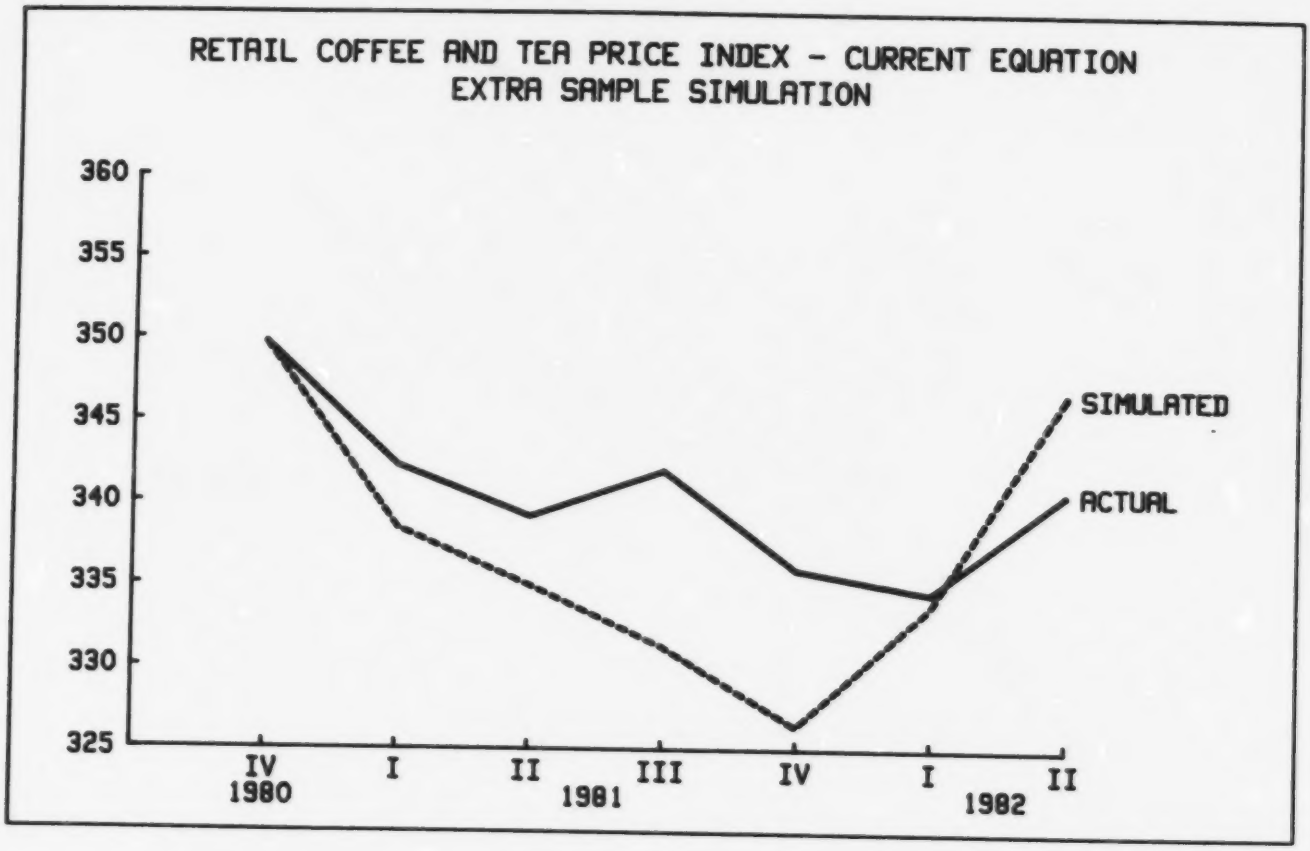
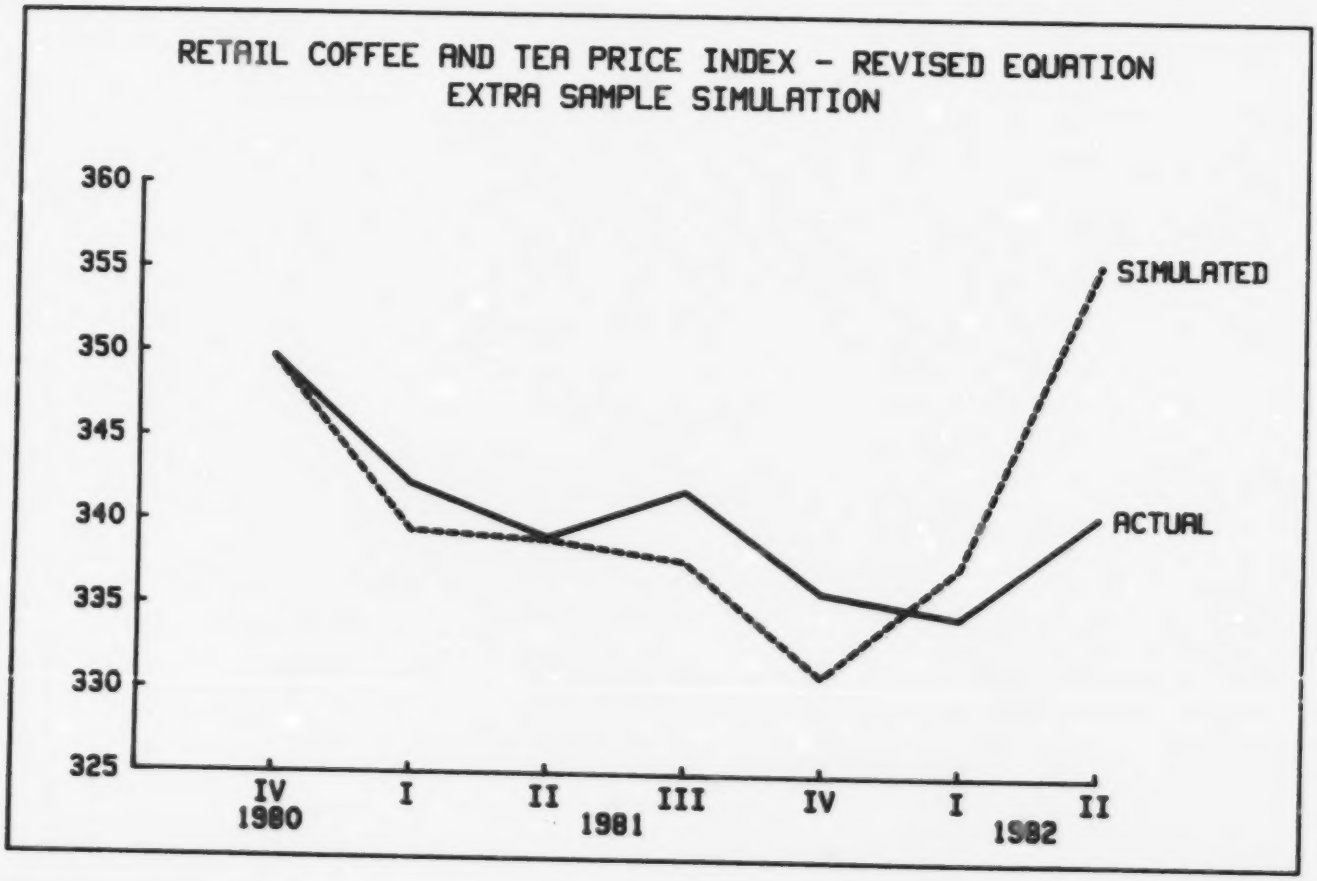

PROCESSED VEGETABLES PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
310
290
270
250
230
ACTUAL
SIMULATED
IV
1980
I
II
III
1981
IV
I
1982
II

FIGURE 13


RETAIL COFFEE AND TEA PRICE INDEX - CURRENT EQUATION
EXTRA SAMPLE SIMULATION
360
355
350
345
340
335
330
325
SIMULATED
ACTUAL
IV
1980
I
II
III
IV
1981
I
II
1982


RETAIL COFFEE AND TEA PRICE INDEX - REVISED EQUATION
EXTRA SAMPLE SIMULATION
360
355
350
345
340
335
330
325
SIMULATED
ACTUAL
IV
1980
I
II
III
IV
1981
I
II
1982

PART IV - The Extra-Sample Simulation of the Revised Model

The final ex-post assessment of the revision of the CPI-Food forecasting model is derived from the results of an extra-sample recursive and simultaneous simulation. Table 4 contains six quarterly ex-post forecasts and one ex-ante annual forecast. The ex-post forecast period starts in the first quarter of 1981 and ends in the second quarter of 1982. The ex-ante forecast gives a model projection for 1983 annual food price movements.

Background

The recursive character of the simulation is related to the fact that once a first-quarter forecast has been generated, this forecast is used in the following quarter forecast as a lagged endogenous price. Thus, a slight deviation in the first-quarter forecast may affect the result for the remaining quarters. Consequently, quarterly forecast are sometimes more accurate than annual forecasts.

The simultaneous structure of the revised model was taken into account when simulating the entire model. However, it should be repeated that in estimating the coefficients the simultaneous structure of the model was ignored, since the analysis was restricted to the ordinary least squares method of estimation.

TABLE 4 EXTRA-SAMPLE DYNAMIC AND SIMULTANEOUS SIMULATION

	1981 Q1			1981 Q2			1981 Q3			1981 Q4			1982 Q1			1982 Q2			1983 Annual	
	A	C	R	A	C	R	A	C	R	A	C	R	A	C	R	A	C	R	A C	R
Food	282.3 3.1	281.3 2.7	282.7 3.2	288.8 2.3	288.0 2.4	290.1 2.6	296.1 2.5	298.3 3.6	299.6 3.3	294.4 -0.6	300.1 0.6	299.0 -0.2	300.1 1.9	304.8 1.6	304.4 1.8	312.3 4.1	341.1 3.1	315.0 3.5	331.0 6.3	325.0 4.4
Food purchased from stores	288.5 3.3	286.1 2.4	287.9 3.0	294.8 2.2	291.9 2.0	294.5 2.3	302.2 2.5	302.7 3.7	304.1 3.3	298.5 -1.2	302.3 -0.1	301.2 -1.0	303.9 1.8	307.7 1.8	307.6 2.1	317.4 4.4	319.2 3.7	320.8 4.3	335.5 6.5	327.3 3.9
Meat, Poultry & Fish	291.8 1.2	290.1 0.7	291.0 1.0	286.8 -1.7	292.7 0.9	287.1 -1.3	298.9 4.2	304.1 3.9	299.9 4.5	296.4 -0.8	303.5 -0.2	296.4 -1.2	291.6 -1.6	301.0 -0.8	292.1 -1.5	309.1 6.0	317.1 5.3	310.9 6.4	327.6 6.4	319.8 3.9
Beef	299.9 0.4	295.9 -1.0	295.8 -1.0	292.5 -2.5	296.4 0.2	289.7 -2.1	297.8 1.8	298.6 0.7	294.8 1.8	285.7 -4.1	290.9 -2.6	282.9 -4.0	274.2 -4.0	284.1 -2.3	273.7 -3.3	303.8 10.8	308.7 8.7	300.6 9.8	319.6 9.4	299.3 2.5
Pork	267.3 0.7	263.6 -0.7	263.3 -0.8	256.7 -4.0	264.7 0.4	255.5 -3.0	283.7 10.5	293.3 10.8	284.3 11.3	283.5 -0.1	293.7 0.1	282.1 -0.8	282.2 -0.5	291.8 -0.6	279.1 -1.1	309.1 9.5	312.4 7.1	308.2 10.4	325.7 2.6	336.5 6.0
Chicken	305.3 4.3	295.6 1.0	304.2 3.9	296.5 -2.9	302.1 2.2	301.8 -0.8	315.5 6.4	312.9 3.6	318.1 5.4	327.5 3.8	323.0 3.2	326.2 2.5	327.3 -0.1	323.6 0.2	326.1 -0.0	313.4 -4.2	320.6 -0.9	312.8 -4.1	330.0 3.3	323.0 1.1
Turkey	258.5 0.9	269.3 5.1	267.3 4.3	278.4 7.7	277.7 3.1	271.3 1.5	276.5 -0.7	288.1 3.7	282.1 4.0	286.2 3.5	295.9 2.7	286.6 1.6	300.9 5.1	300.7 1.6	289.7 1.1	300.5 -0.1	301.8 0.4	291.6 0.7	306.7 1.2	309.6 2.2
Dairy Products	271.0 4.2	268.8 3.3	268.8 3.3	279.7 3.2	277.1 3.1	277.1 3.1	286.5 2.4	284.3 2.6	284.3 2.6	292.3 2.0	292.0 2.7	292.0 2.7	298.9 2.3	300.7 3.0	300.6 2.9	308.3 3.1	304.9 1.4	304.8 1.4	333.6 7.3	335.7 8.0
Eggs	257.4 6.1	251.1 3.5	255.1 5.2	262.5 2.0	252.6 0.6	258.0 1.1	270.2 2.9	257.7 2.0	265.3 2.8	269.0 -0.4	256.1 -0.6	264.4 -0.3	262.0 -2.6	251.6 -1.8	261.7 -1.0	258.3 -1.4	249.1 -1.0	261.1 -0.2	262.7 0.5	266.5 2.0
Cereal and Bakery Products	298.0 3.4	293.5 3.7	292.7 3.4	311.1 4.4	303.8 3.5	302.9 3.5	314.9 1.2	310.9 2.3	309.7 2.2	314.9 0.0	317.5 2.1	315.1 1.7	318.1 1.0	322.9 1.7	319.5 1.4	327.7 3.0	329.4 2.0	324.4 1.5	343.0 4.7	342.6 4.5
Fruit and Vegetables	304.6 7.2	304.7 7.3	307.5 8.2	331.3 8.8	325.5 6.8	336.3 9.4	334.2 0.9	343.2 5.4	348.0 3.5	313.1 -6.3	321.5 -6.3	315.9 -9.2	344.7 10.1	344.3 7.1	342.4 8.4	362.4 5.1	373.7 8.5	370.5 8.2	373.1 6.8	353.5 1.2
Fresh Fruit	284.5 -5.7	321.2 -6.4	310.5 2.9	308.9 8.6	368.8 14.8	354.3 14.1	346.3 12.1	406.7 10.3	394.8 11.4	340.6 -1.6	343.9 -15.4	331.2 -16.1	357.9 5.1	362.2 5.3	354.3 7.0	400.1 11.8	436.6 20.5	423.8 19.6	405.0 4.2	386.7 -0.5
Apples	238.6 -8.9	315.8 20.6	315.8 20.6	267.4 12.1	381.0 20.6	381.0 20.6	345.9 29.4	459.2 20.5	459.2 20.5	362.2 4.7	315.2 -31.4	315.2 -31.4	384.4 6.1	346.7 1.0	346.7 1.0	435.8 13.4	423.7 22.2	423.7 22.2	391.3 -2.4	378.6 -5.6
Bananas	347.4 2.5	356.0 5.0	355.7 4.9	393.4 13.2	393.1 10.4	386.6 8.7	352.5 -10.4	370.4 -5.8	359.9 -6.9	250.8 -0.5	372.5 0.6	356.4 -1.0	359.3 2.4	381.2 2.3	367.8 3.2	385.5 7.3	430.4 12.9	403.9 9.8	410.6 16.8	395.7 12.6
Oranges	205.8 -12.6	234.5 -0.4	209.3 -11.1	198.8 -3.4	241.0 2.8	210.3 0.5	226.8 14.1	279.3 15.9	257.1 22.3	226.5 -0.1	274.7 -1.6	253.8 -1.3	252.6 11.5	284.1 3.4	272.9 7.5	282.6 11.9	336.6 18.5	321.2 17.7	302.0 -1.0	275.3 -9.7
Processed Fruit	279.8 3.1	282.2 4.0	281.4 3.7	299.3 7.0	292.4 3.6	290.7 3.3	306.9 2.5	303.3 3.7	300.4 3.3	313.3 2.1	311.9 2.8	307.5 2.4	321.8 2.7	321.3 3.0	316.3 2.9	334.3 3.9	331.5 3.2	325.9 3.0	346.3 3.5	345.7 3.3
Fresh Vegetables	368.3 23.1	333.5 11.4	354.7 18.5	410.2 11.4	340.7 2.2	389.1 9.7	372.1 -9.3	348.8 2.4	369.7 -5.0	301.2 -19.1	333.9 -4.3	321.6 -13.0	372.5 23.7	379.6 13.7	370.6 15.2	370.5 -0.5	389.5 2.6	378.2 2.1	372.9 10.4	330.4 -2.2

	1981 Q1			1981 Q2			1981 Q3			1981 Q4			1982 Q1			1982 Q2			1983 Annual	
	A	C	R	A	C	R	A	C	R	A	C	R	A	C	R	A	C	R	C	R
Lettuce	268.6	298.2	274.3	299.5	325.1	293.4	310.4	263.1	301.0	315.2	361.6	333.7	473.6	470.1	423.7	372.7	419.3	352.3	347.0	304.5
	-11.7	-2.0	-9.8	11.5	9.0	7.0	3.6	-19.1	2.6	1.5	37.4	10.9	50.3	30.0	27.0	-21.3	-10.8	-16.9	-1.5	-13.6
Potatoes	550.8	413.9	514.0	656.5	447.0	658.1	643.3	571.2	622.0	418.8	438.6	413.6	416.4	412.4	414.6	481.3	465.4	474.9	445.7	451.3
	23.2	-7.4	15.0	19.2	8.0	28.0	-2.0	27.8	-5.5	-34.9	-23.2	-33.5	-0.6	-6.0	0.2	15.6	12.9	14.5	-1.5	-0.3
Tomatoes	382.4	347.0	347.0	381.4	319.6	319.6	274.8	297.7	297.7	268.7	308.1	308.1	336.8	351.2	351.2	316.9	357.3	357.3	381.4	331.4
	40.7	27.7	27.7	-0.3	-7.9	-7.9	-27.9	-6.9	-6.9	-2.2	3.5	3.5	25.3	14.0	14.0	-5.9	1.7	1.7	17.9	2.4
Processed Vegetables	246.9	245.5	248.4	258.0	252.0	260.4	270.6	259.4	273.0	280.9	266.0	287.7	291.6	270.9	298.5	308.0	274.3	305.8	326.4	330.5
	4.6	4.0	5.2	4.5	2.6	4.8	4.9	2.9	4.8	3.8	2.5	5.4	3.8	1.8	3.8	5.6	1.3	2.4	5.1	6.5
Fats and Oils	242.0	245.5	243.8	244.3	251.2	247.4	245.6	257.3	252.3	244.8	262.2	254.7	246.6	265.8	257.0	250.9	268.1	264.6	272.8	270.2
	2.2	3.6	2.9	3.1	2.3	1.5	0.5	2.4	2.0	-0.3	1.9	1.0	0.7	1.4	0.9	1.7	0.9	3.0	8.1	7.1
Sugar and Sugar Preparations	419.7	466.4	447.4	392.1	428.5	421.9	389.1	420.7	408.4	363.4	420.3	385.9	367.0	431.1	393.5	365.0	426.9	368.3	388.1	383.9
	-10.1	-4.6	-8.5	-10.8	-8.1	-5.7	-0.8	-1.8	-3.2	-6.6	-0.1	-5.5	1.0	2.6	2.0	-0.5	-1.0	-6.4	7.2	6.1
Coffee and Tea	342.2	338.4	339.4	339.1	334.9	338.9	341.9	331.2	337.7	335.9	326.5	330.9	334.5	333.8	337.5	340.6	346.6	355.5	351.7	328.0
	-2.1	-3.2	-2.9	-0.9	-1.0	-0.1	0.8	-1.1	-0.4	-1.8	-1.4	-2.0	-0.4	2.2	2.0	1.8	3.8	5.3	3.9	-3.1
Other Food Purchased from Stores	286.6		283.6	298.9		296.6	308.5		310.4	308.3		327.0	313.9		342.9	329.5		354.2		340.6
	5.6		4.5	4.3		4.6	3.2		4.7	-0.1		5.3	1.8		4.9	5.0		3.3		4.2
Prepared and Partly Prepared Main Dishes	95.2		96.6	98.6		101.4	102.4		105.2	103.8		106.5	105.8		108.0	110.9		108.0		113.4
	4.0		5.6	3.6		5.0	3.9		3.7	1.4		1.2	1.9		1.4	4.8		0.0		1.9
Food Purchased from Restaurants	257.3	260.6	260.5	264.5	269.4	269.1	271.2	277.9	277.5	276.5	285.5	285.0	283.1	288.5	288.1	291.1	291.7	290.8	311.3	311.5
	2.2	3.5	3.5	2.8	3.4	3.3	2.5	3.2	3.1	2.0	2.7	2.7	2.4	1.1	1.1	2.8	1.1	0.9	5.6	5.7

The Results

Quarterly Ex-Post Simulations

The simulation results show that the revision of the CPI-Food model significantly improved its quarterly forecasting abilities. The percentage changes in the aggregate price indexes, as well as the commodity price indexes, were forecast with greater quarterly accuracy by the revised model.

For the simulation range, the actual price index values and percentage changes are listed in columns A of Table 4. The simulation results of the current model appear in columns C and the results of the revised model's simulation are given in columns R.

The results for the period 1981 Q1-1982 Q2 show that the percent change in the total food price index, as simulated by the revised model, is closer to the actual percentage change on 5 out of 6 quarters than the current model simulation.

The revised model simulates the food purchased from restaurants price index with only marginally better accuracy than the current model.

The percent change in the food purchased from stores component is best simulated with the revised model in 5 out of 6 quarters.

The meat, poultry and fish price index and its rate of change are forecast very accurately even where the current model forecasts a wrong sign for the index change.

Deviations or loss of accuracy in the total food forecast of the revised model are the result of improvements in the fresh vegetable equation. This is because fresh fruit and vegetable current price equations have canceling forecasting errors. Improvements in one set of equations distorts the aggregate forecast until improvement is realized in the other set of equations.

Overall, most of the transformed equations entail significant improvements in quaterly simulations of food prices.

Annual ex-ante forecast

Using the information available as of mid-May 1983, two forecasts were generated: one using the current model and another using its proposed revised version. The results of the revised and the current models are pure model results.(18) No subjective adjustment has been made to the CPI equations. The results appear in the last columns of Table 4.

The revised model predicted a food price inflation of 4.4%, nearly 2 percentage points lower than the forecast by the current model (6.3%). There is a 2.6% gap between the two

forecasts for the annual rate of change of the price index for food purchased from stores. Higher beef, chicken, fruit and vegetable, fat and oil, and coffee and tea current model price forecasts are responsible for most of this difference.

The price index forecasts for food purchased from restaurants are more in line with one another. The two equations give, however, different results when the recursive nature of the forecast is considered. The forecast price index for food purchased from stores is incorporated into the right hand side of each equation to generate the forecast for the food purchased from restaurants price index. Because of difference in the forecasts for the former index, the current equation for food purchased from restaurants underestimates the latter index as compared to the revised equation.

Conclusion

The revision of the CPI-Food forecasting model has resulted in a significant improvement in both the explanatory and forecasting capabilities of the quarterly model.

The estimated coefficients shed more light on the price determination process of food products and the structure of the model accurately explains food price fluctuations. Simultaneity among various meat prices, the relatively important role of

demand factors and the low order of lags are the major results of the revised model.

The extra-sample simulation results are convincing. Improvements in forecasting are evident from the results of individual equation simulations and from the simulation of the simultaneous model. Most food price index movements are simulated with greater quarterly accuracy than with the FARM model.

A close examination of the results suggests that further improvements are possible. In Appendix II, one possibility is investigated, namely the substitution of per capita disposable income for the personal expenditures on non-durable goods to eliminate of the effect of the change in consumer behavior in recent years with regard to savings and other non-food items.

A more precise definition and forecast of mark-ups in the food industry and its sub-industries would also be of great help to food price forecasting. The recent erratic behavior of margins in some sub-industries, such as beef and pork, probably weakens the explanatory power of the revised model.

The construction of a food packaging index could also be useful with respect to forecasting selected retail food prices, as would be the construction and forecast of an energy price index for the food industries.

APPENDIX I

Retail Pork Prices and the Exchange Rate

Retail pork prices are estimated to be very responsive to the exchange rate. A 1% increase in the exchange rate is estimated to produce a 0.4% increase in retail pork prices. For example, a drop from 82¢ to 81¢ in the value of the Canadian dollar with respect to its U.S. counterpart would increase the retail price of pork by 0.5%. The magnitude of this elasticity can be defended by examining the commodity prices involved in the index because "pork exports are primarily in the form of cuts (...) and the importance of the import market varies by type of products". (19)

Pork is a traded commodity. Canada imports fresh pork from the United States (5% of our production) and exports pork to the U.S. and Japan markets (10-15% of our production). (19) Because the volume of exports affects the supply of pork to retail markets, the effect of the exchange rate on retail prices can be understood through its effect on supply. A lower Canadian dollar stimulates pork exports, thus reducing the supply to retail markets and subsequently increasing the retail price.

It has been hypothesized that the effect of the exchange rate movements on CPI-Pork movements was primarily due to our exports of fresh lean cuts to the United States and Japan. To

verify this hypothesis, using montly data the author regressed the percentage change in some components of the CPI-Pork on the percent changes in hog prices (with and without a quarter lag), wage rates in slaughtering and packing plants, the retail price of beef, the exchange rate and seasonal dummies. The consumer price indexes for bacon, loin and ham have been regressed on these variables. The results are given in Table A.1.

TABLE A.1

Percentage Change in Some CPI-Pork Components

	INT	D_1	D_2	D_3	$\dot{Ph}_t$	$\dot{Ph}_{t-1}$	$\dot{W}_t$	$\dot{P}_{bt}$	$\dot{E}_t$
BACON	-0.01	-0.04	-0.04	0.04	0.45	0.32	0.53	0.19	-0.16
	(-0.27)	(-1.57)	(-1.52)	(1.44)	(6.48)	(4.64)	(1.44)	(1.50)	(-0.31)
HAM	0.01	-0.01	-0.05	-0.01	0.27	0.21	0.39	0.13	0.31
	(1.22)	(-0.42)	(-3.53)	(-0.82)	(6.86)	(5.25)	(1.87)	(1.80)	(1.07)
LOIN	-0.03	0.03	0.04	0.09	0.33	0.17	-0.18	-0.03	0.97
	(-2.01)	(1.50)	(1.95)	(4.37)	(6.15)	(3.27)	(-0.63)	(0.32)	(2.52)

	R^2	D.W.	F
BACON	0.84	1.99	22.85
HAM	0.85	1.99	24.65
LOIN	0.84	1.86	22.36

The estimation was performed using OLS and monthly data ranging from January 1971 to December 1981.

INT: intercept; D_i : Seasonal dummy for the i-th quarter

$\dot{Ph}_t$: percent change in the price of hogs (Index 100, Ontario) in period t

$\dot{W}_t$: percent change in wage rates in slaughtering and processing plants in period t

$\dot{P}_{bt}$: percent change in the CPI-Beef in period t

$\dot{E}_t$: percent change in the Canada-U.S. exchange rate

Exchange rate movements are not estimated to have any significant effect on the retail prices of bacon and ham. The exchange rate effect is entirely embedded in the price of hogs effect. However, variations in the exchange rate have a very significant effect on changes in the retail loin price. This confirms the hypothesis.

The last piece of evidence for the high elasticity of retail pork prices with respect to the exchange rate is the stability of the coefficient over various estimation ranges and specifications.

These equations have even more to say on the price formation of pork products. In the case of bacon and ham, which undergo more processing than some products, the price-leveling effect is greater than for loin. The elasticity of the price of hogs (lagged a quarter) is much closer to the elasticity of the non-lagged price of hogs for bacon and ham retail prices. The processed nature of bacon and ham is also reflected in the significance level of the wage factor coefficient. This comparison of estimation results also illustrates the substitution structure for pork products. High price loin cuts do not have a significant relationship with beef products as a whole, while bacon and ham (particularly the latter) are more closely related to all cuts of beef.

Returning to the pork price equation of Table 1, the estimation reveals that retail pork price movements experience a significant upsurge in the summer corresponding to seasonally increased demand.

The estimation also demonstrates the substitutability of beef and pork. It is estimated that 10% increase in retail beef prices increases the consumer demand for certain pork cuts to the extent that retail pork prices rise 1%.

Since the CPI-Pork somewhat reflects the processed nature of pork products, the percentage change in wages has a positive effect on changes in retail pork prices. Because of the inclusion in the CPI-Pork of some fresh cut prices, the coeffient is not very significant.

In 1982, foot-and-mouth disease in Denmark contributed to a 10% increase in Canadian fresh loin exports to Japan,(20) thus reducing the domestic supply in Canada. The overall effect may not be very significant, but the dummy variable has improved the simulation for the two first quarters of 1982.

APPENDIX II

Substitution of Per Capita Disposable Income by Expenditures on Non-Durable Goods in the Beef Retail Price Equation

In the beef retail price equation, personal non-durable expenditures have been substituted for per capita disposable income, under the assumption that non-durable expenditures would be more closely related to beef demand than income, because income can be partitioned according to different consumption and saving patterns over time.

However, the results do not support this assumption. The first equation of Table 1 (page 27) was estimated with the income variable replaced by the personal non-durable expenditure variable (Source: Statistics Canada, Cansim: D040046, unadjusted for seasonal variations). A negative coefficient, barely significant, resulted for the quarterly changes in non-durable expenditures variable.

The reason for this discrepency is twofold. First, the consumption patterns for the non-food components of non-durable expenditures are likely more flexible than food expenditures. As a result, an increase in one type of non-durable expenditures may easily be compensated by changes in another type of non-durable expenditures. For example, increased energy prices may reduce

energy consumption enough to offset increased food expenditures in that particular period. In this case, a zero increase in non-durable expenditures could accurately reflect a rise in demand for beef. However, this case depends on demand elasticities and price level changes.

Secondly, substitution between meats makes changes to expenditure patterns which are less noticable in the expenditure data. This may be the major reason to rule out the substitution of per capita disposable income by personal non-durable expenditures. Income affects expenditure patterns in ways that are not completely reflected in non-durable expenditure data.

FOOTNOTES

(1) One of the constraints to this CPI forecasting model is the technical necessity to estimate each equation separately. The simultaneous structure of the retail meat section is thus ignored in the estimation while it is effective during the model simulation.

(2) This section is an update to the section II.6.3 "The Consumer Price Index for Food" of the series of technical reports on the Food and Agricultural Regional Model (FARM), Agriculture Canada, Ottawa, 1980.

(3) Some equations have not been considered in this revision because of their satisfactory forecasting performance in the recent past. This is not to say that no improvement can be made. These equations are for fluid milk, ice cream, butter, margarine, processed cheese, skim milk powder and evaporated milk consumer price indexes.

(4) R.M. Lamm, "Dynamic of Food Price Inflation" in Western Journal of Agricultural Economics, 1979, pp. 119-132.

(5) These 24 equations form what is called below the initial block.

(6) "There are many theories of price determination, non of which can be demonstrated superior to other" (R. McFALL LAMM and P.C. WESCOTT, "The Effects of Changing Input Costs on Food Prices" in American Journal of Agricultural Economics, 1981 pp. 187-196) but there is evidence of mark-up pricing in the food retailing industry where mark-up pricing is dependant upon demand conditions.(7)

(7) R.E. LOPEZ, "The Determinants of Food Prices in Canada: Some Policy Implications", Agriculture Canada, forthcoming publication.

(8) Implicit price derived from Statistics Canada's annual data on production and farm value of lettuce. CANSIM Nos. D 220309 and D 220315.

(9) Implicit price derived from Statistics Canada's (External Trade Division) monthly data on imports and value of imports of black tea from all countries.

(10) Sum of production and previous quarter stocks of turkey in Canada using data already included in FARM.

(11) A three-city average (Montreal, Toronto, Winnipeg), standing as a proxy for a Canadian average, calculated (in $/75 lb) from data published in Agriculture Canada, Fruit, Vegetables and Honey, Crops and Market Report.

(12) R. McFALL LAMM and P.C. WESCOTT, Op-cit.

(13) $U = \sqrt{\frac{\Sigma(PA)^2}{\Sigma A^2}} \neq \frac{\sqrt{\Sigma(P-A)^2}}{\sqrt{\Sigma A^2} + \sqrt{\Sigma P^2}}$, the first U-statistic defined by Theil, which does not give a good ranking of forecasts

where P: predicted value
where A: actual value

(14) Statistic Canada, The Consumer Price Index, Reference paper, concepts and Procedures, Updating based on 1978 expenditures. Catalogue No. 62-553

(15) See G. HEWSTON and D. RICARD, "Marketing channels and Price Formation for Pork" in Food Market Commentary, vol 5. no. 2, 1983; and P.C. WESCOTT, "Monthly Food Price Forecasts" in Agricultural Economic Research, vol 33., no. 3, 1981.

(16) These results were obtained with the simulation of each equation separately.

(17) R. McFALL LAMM and P.C. WESCOTT, Op-cit.

(18) Deviation in forecasts for the CPI-dairy products, CPI-cereal and barley products and CPI-apples originate from the different estimation periods. The revised model use coefficients estimated from 1971Q1 while the estimation range for the current model is wider.

(19) G. HEWSTON and D. RICARD, Op-cit.

(20) Agriculture Canada, Canada Livestock and Meat Trade Report, Ottawa, Vol. 63, no. 52, 1982.

POOR

QUALITY

ORIGINAL